UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

DEC 17 2003

MEMORANDUM FOR: CDFG Research Permit Program 2002-2004 File

FROM: Rodney R. McInnis *Rodney R McInnis*
Acting Regional Administrator

SUBJECT: Biological opinion on approval of Year 2002-2004 California Department of Fish and Game Research Program, including Scientific Collector Permit-holder projects, under the July 2000 4(d) Rule Research Limit.

The National Marine Fisheries Service (NOAA Fisheries) proposes to limit Endangered Species Act (ESA) of 1973, as amended, take prohibitions, under the authority of section 4(d) of the ESA, for juvenile and adult Southern Oregon/Northern California Coast and Central California Coast coho salmon (*Oncorhynchus kisutch*), California Coastal and Central Valley spring-run Chinook salmon *(O. tshawytscha)*, Northern California, Central California Coast, South-Central California Coast, and Central Valley steelhead *(O. mykiss)* related to 78 scientific research and monitoring projects in California. This authorization would be in effect through December 31, 2004 (unless it is modified, suspended or revoked sooner), and would be subject to the limitations of the ESA and the regulations in 50 CFR parts 222, 223, and 224.

The attached opinion analyzes our proposed approval of the research program submitted by the California Department of Fish and Game (CDFG). NOAA Fisheries anticipates that the Research Program would provide valuable information for the conservation of listed species. Based on our evaluation of the Research Program, none of the projects, singly or in combination, are likely to jeopardize the continued existence of threatened anadromous salmonids in California.

BIOLOGICAL OPINION

AGENCY: National Marine Fisheries Service

ACTION: Limit ESA take prohibitions, under the authority of section 4(d) of the ESA, for juvenile and adult coho, Chinook, and steelhead in eight Evolutionarily Significant Units related to 78 scientific research and monitoring projects in California

CONSULTATION
CONDUCTED BY: National Marine Fisheries Service, Southwest Region

FILE NUMBER:

DATE ISSUED: DEC 17 2003

I. CONSULTATION HISTORY

There are eight Evolutionarily Significant Units[1] (ESU) of threatened anadromous salmonids in California covered in this biological opinion (Figure 1; Table 1 attached). The National Marine Fisheries Service (NOAA Fisheries) has established protective regulations for these eight ESUs through promulgation of three separate Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1538(a)(1)), section 4(d) rules (62 Federal Register (FR) 38479, 65 FR 42422, and 67 FR 1116). All of the protective regulations for these ESUs have limits to the take prohibitions for research and monitoring activities. The research limits provide that the prohibitions of section 9(a)(1) of the ESA do not apply to scientific research and monitoring activities submitted by a state fishery agency that meet the criteria specified in the limit.

On June 13, 2002, June 25, 2002, and May 16, 2003, the California Department of Fish and Game (CDFG) submitted requests for limits to take prohibition for threatened anadromous salmonids in California. The requests described projects to be conducted by CDFG employees and recipients of CDFG scientific collector permits; collectively these projects are called the Program. NOAA Fisheries collaborated with CDFG on numerous occasions to obtain clarification on the applications submitted. NOAA Fisheries also contacted all 78 applicants and requested clarification of their projects regarding specifics such as sampling location, timing, and amount of take estimated. This biological opinion is based on information contained in the 78 applications submitted by CDFG, e-mail messages, and telephone conversations with the

[1] For purposes of conservation under the Endangered Species Act, an Evolutionarily Significant Unit (ESU) is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991).

applicants. A complete administrative record of this consultation is on file at the NOAA Fisheries Santa Rosa Office.

NOAA Fisheries has determined that the CDFG Program meets the criteria found in the research limits and will act to conserve the affected listed species. NOAA Fisheries' review of that Program is set out in the December 3, 2003, document titled "Determination for California Department of Fish and Game request for take prohibition limit for research and monitoring activities - 2003 and 2004."

II. DESCRIPTION OF THE PROPOSED ACTION

NOAA Fisheries proposes to limit ESA take prohibitions, under the authority of section 4(d) of the ESA, for juvenile and adult Southern Oregon/Northern California Coast (SONCC) and Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*), California Coastal (CC) and Central Valley spring-run (CVSR) Chinook salmon (*O. tshawytscha*), Northern California (NC), Central California Coast (CCC), South-Central California Coast (SCCC), and Central Valley (CV) steelhead (*O. mykiss*) related to 78 scientific research and monitoring projects in California. This authorization would be in effect through December 31, 2004 (unless it is modified, suspended or revoked sooner), and would be subject to the limitations of the ESA and the regulations in 50 CFR parts 222, 223, and 224.

While some of the projects discussed in this opinion are located within the Sacramento River winter-run Chinook salmon ESU, the projects either will not affect this endangered species or are already permitted through section 7 or section 10(a)(1)(A) of the ESA. Therefore, the Program effects on the Sacramento River winter-run Chinook salmon ESU are not considered in this consultation.

A. Research and Monitoring Program Description

The CDFG has submitted a request for authorization to operate the Program under the limits to take prohibition for threatened anadromous salmonids in California. The Program contains 78 projects throughout California: 40 conducted by CDFG researchers and 38 conducted by researchers with a CDFG scientific collectors permit. The projects may affect eight threatened salmon and steelhead ESUs in California (Table 1, attached). NOAA Fisheries will require detailed annual reports from the CDFG that document research or monitoring-related take under this authorization and forecasting activities and the take anticipated for the following year.

The Program encompasses a diverse set of research objectives, including: (1) determining the abundance, distribution, and condition of adult and juvenile fish; (2) surveying spawning and rearing of adult and juvenile listed and unlisted fish; (3) conducting genetic studies using tissue and scale samples; (4) investigating migration timing; (5) studying estuarine ecology; (6) classifying and monitoring habitats; (7) determining habitat use by adult and juvenile fish; (8)

prioritizing inventoried streams for restoration work and assessing effectiveness of restoration efforts; (9) evaluating effect of contaminated water on fish species; (10) examining salmonids for the presence of pathogens; (11) evaluating fish entrainment, survival, and movement through dams; (12) developing population models of listed fish; (13) demonstrating field equipment and techniques to study fish; and (14) examining size of various age classes of fish and growth rate. Many of these research projects focus on monitoring and evaluating management actions and tasks that are recommended for the conservation of listed salmonid populations.

B. Description of the Action Area

The action area includes (1) all coastal streams from the Oregon/California border, south to, but not including, the Santa Maria River (San Luis Obispo County, California), and (2) all the streams of the Sacramento-San Joaquin River Basin of the Central Valley of California. (See Table 1 for information on the ESUs in the action area).

C. Requested amount of Take

The total amount of annual take requested by CDFG of listed juvenile and adult salmonids from each ESU for the Program is summarized in Table 2 below. The amount of annual take of listed juvenile and adult salmonids requested for each ESU for each project in the Program is listed in Table 3 (attached).

Table 2.
Estimated take of adult and juvenile fish for eight Evolutionarily Significant Units resulting from 78 projects in CDFG's Research Program.

	Adult			Juvenile					
Evolutionarily Significant Unit	Non-lethal	Lethal	% Lethal take	Non-lethal	Lethal	% Lethal take	Total take	% Adult take	% Juvenile take
So.Oregon/No. California Coasts coho salmon	800	15	1.8	203,118	688	0.3	204,621	0.4	99.6
Central California Coast coho salmon	0	0	0.0	24,550	234	0.9	24,784	0.0	100.0
California Coastal Chinook salmon	500	10	2.0	191,590	1,690	0.9	193,790	0.3	99.7
Northern California steelhead	280	10	3.4	346,304	4,968	1.4	351,562	0.1	99.9
Central California Coast steelhead	75	0	0.0	37,404	765	2.0	38,244	0.2	99.8
South Central California Coast steelhead	0	0	0.0	8,275	60	0.7	8,335	0.0	100.0
Central Valley spring-run Chinook salmon	24,830	59	0.2	787,036	14,261	1.8	826,186	3.0	97.0
Central Valley steelhead	6,475	134	2.1	38,170	2,020	5.3	46,799	14.1	85.9

D. Measures to Reduce the Impacts of the Program

To minimize the effect of take on listed salmonids during the activities of the Program, NOAA Fisheries has reviewed each application to ensure that the amount of take proposed by individual projects, groups of projects within watershed, or the Program as a whole is commensurate with the status of the sub-population of salmon and steelhead affected by the Program. The CDFG has indicated that all scientific research and monitoring projects will be conducted by their own staff or by researchers who will be overseen by or coordinated with the CDFG. Each researcher under the Program must comply with NOAA Fisheries' conditions and requirements to insure responsible treatment and handling of listed species and to minimize take and the effects of take on the species. Researchers will insure that all persons operating under the Program will be properly trained and have access to properly maintained state-of-the-art equipment. Researchers must use unintentional lethal takes (indirect mortalities) when conducting their research unless they have requested intentional lethal take (direct sacrifice) and have approval for this in their projects. Researchers are required to coordinate with other co-managers and researchers to ensure that no unnecessary duplication or adverse cumulative effects to ESA-listed species occur as a result of his/her activities.

The CDFG has indicated that electrofishing activities will be conducted according to the NOAA Fisheries Electrofishing Guidelines published in June 2000. The CDFG has provided assurances that research activities undertaken by CDFG will obtain and comply with conditions specified in applicable Federal, State, tribal, and local licenses, permits, and authorizations necessary for the conduct of activities provided for in this authorization.

Finally, NOAA Fisheries will monitor actual annual takes of listed fish species associated with the Program (as provided to NOAA Fisheries in annual reports) and shall adjust annual permitted take levels if they are deemed to be excessive or if cumulative take levels are determined to operate to the disadvantage of the listed species.

III. DESCRIPTION AND STATUS OF THE SPECIES AND CRITICAL HABITAT

The proposed action may affect the following listed species. More detailed information related to the listing status, critical habitat, protective regulations, and biological information for the ESA-listed species addressed in this opinion are found in Table 1.

Coho Salmon

SONCC coho salmon ESU, listed as threatened on May 6, 1997 (62 FR 24588)

CCC coho salmon ESU, listed as threatened under the ESA on October 31, 1996 (61 FR 56138)

Chinook Salmon

CC Chinook salmon ESU, listed as threatened under the ESA on September 16, 1999 (64 FR 50394)

CVSR Chinook salmon, listed as threatened under the ESA on September 16, 1999 (64 FR 50394)

Steelhead

NC steelhead ESU, listed as threatened under the ESA on June 7, 2000 (65 FR 36074)

CCC steelhead, listed as threatened under the ESA on August 18, 1997 (62 FR 43937)

SCCC steelhead, listed as threatened under the ESA on August 18, 1997 (62 FR 43937)

CV steelhead, listed as threatened under the ESA on March 19, 1998 (63 FR 13347)

The Program activities NOAA Fisheries considers in this biological opinion do not result in any changes or effects to salmonid habitat. Therefore, critical habitat is not likely to be adversely affected by NOAA Fisheries' authorization of the Program, and is not considered further in this opinion.

A. Coho Salmon

1. Life History and Biological Requirements

Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates.

The life history of the coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple 3-year life cycle (Shapovalov and Tatt 1954, Hassler 1987). Adult salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958, Eames *et al.* 1981). Migration continues until March, generally peaking in December and January, with spawning occurring shortly after returning to the spawning ground (Shapovalov and Taft 1954).

Female coho salmon choose spawning sites usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and there is small to medium gravel substrate. The flow characteristics of the location of the redd usually insure good aeration of eggs and embryos, and flushing of waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have nearby overhead and submerged cover for holding adults; water depth of 10-54 cm; water velocities of 20-80 cm/s; clean, loosely compacted gravel (1.3-12.7 cm diameter) with less than 20 percent fine silt or sand content; cool water (4-10°C) with high dissolved oxygen (8 mg/l); and an intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Each female builds a series of redds in the gravel, moving upstream as she does so, and deposits a few hundred eggs in each. Fecundity of coho salmon is directly proportional to female size; coho salmon may produce from 1,000-7,600 eggs (reviewed in Sandercock 1991). Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males also may engage in spawning. Coho salmon may spawn in more than one redd and with more than one partner (Sandercock 1991). Coho salmon are ***semelparous***, they spawn once and then die. The female may guard a nest for up to two weeks (Briggs 1953).

The eggs generally hatch between 4 to 8 weeks later, depending on water temperature. Survival and development rates depend on temperature and dissolved oxygen levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and fry survival drops sharply when fines make up 15 percent or more of the substrate. The newly-hatched fry remain in the gravel from two to seven weeks until emergence from the gravels (Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, they often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools, with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August, they are in the deep pools. Juvenile coho salmon prefer well shaded pools at least one meter deep with dense overhead cover; abundant submerged cover composed of undercut banks, logs, roots, and other woody debris; preferred water temperatures of 12-15°C (Brett 1952, Reiser and Bjornn 1979), but not exceeding 22-25°C (Brungs and Jones 1977) for extended time periods; dissolved oxygen levels of 4-9 mg/l; and water velocities of 9-24 cm/s in pools and 31-46 cm/s in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 10-15°C (Bell 1973, McMahon 1983). Growth is slowed considerably at 18°C and ceases at 20°C (Stein *et al.* 1972, Bell 1973).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter in the pools. As water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow down. During December-February, winter rains result in increased stream flows and by March, following peak flows, fish again feed heavily on insects and crustaceans and grow rapidly.

In the spring juvenile coho salmon, as yearlings, undergo a physiological process known as **smoltification**, which prepares them for living in the marine environment. They begin to migrate downstream to the ocean during late March and early April, and outmigration usually peaks in mid-May, if conditions are favorable. At this point, the smolts are about 10-13 cm in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown *et al.* 1994). Although they can range widely in the North Pacific, movements of coho salmon from California are not well known.

2. <u>Status of Stocks</u>

a. SONCC Coho Salmon

Information regarding the status of coho salmon in the SONCC ESU was obtained from an analysis of relatively recent (1987-1991) occurrence of coho salmon in streams historically known to support coho populations (Brown *et al.* 1994). Of 115 historical streams in the SONCC ESU for which recent data were available, 73 (63 percent) were determined to still support coho salmon, whereas it was believed they had been lost from 42 (37 percent). Schiewe (1996a) presented more recent data (1995-1996) on presence of coho salmon within the SONCC ESU, which suggested that the percentage of streams still supporting coho salmon was lower than estimated by Brown *et al.* (1994). Of 176 streams recently surveyed in the SONCC ESU, 92 (52 percent) were found to still support coho salmon (P. Adams, NMFS Southwest Fisheries Science Center, personal communication cited in Schiewe 1996a). The percentage of streams still supporting coho salmon was lower (46 percent) in Del Norte County than in Humboldt County (55 percent). It was unclear whether the apparent reduction in percentage of streams occupied by coho salmon was a function of trends in local extinctions or an artifact of sampling error.

Two recent reviews assessing the status of coho salmon stocks in California were also reviewed by the NOAA Fisheries Biological Review Team (BRT). Nehlsen *et al.* (1991) identified coastal populations of coho salmon north of San Francisco Bay (includes portions of the SONCC and CCC ESU's) as being at moderate risk of extinction and Klamath River coho salmon stock of special concern. The Humboldt Chapter of the American Fisheries Society (Higgins *et al.* 1992), utilizing more detailed information on individual river basins, considered three stocks of coho salmon in the SONCC ESU as at high risk of extinction (Scott River [Klamath], Mad River, and Mattole River), and eight more stocks as of special concern (Wilson Creek, Lower Klamath River, Trinity River, Redwood Creek, Little River, Humboldt Bay tributaries, Eel River, and Bear River). In the 1995 status review, the BRT was unanimous in concluding that coho salmon in the SONCC ESU were not in danger of extinction but were likely to become so in the foreseeable future if present trends continued (Weitkamp *et al.* 1995). Including only streams listed in Brown and Moyle (1991), CDFG (2002) found that coho salmon were observed in 143 of 235 (61 percent) streams surveyed during the period covering brood years 1986-1991. This number is similar to the value of 63 percent found by Brown and Moyle (1991) based on information on about half as many streams (115). For brood years 1995-2000, surveys were conducted on 355 of the 392 historical coho salmon streams. Of these, coho salmon were detected in 179 (50 percent), suggesting a decline in occupancy. However, when the analysis was restricted to only the 223 streams for which data were available from both time periods, the percent of streams in which coho were detected went from 62 percent in 1986-1991 to 57 percent in 1995-2000, a change that was not statistically significant (NOAA Fisheries 2003).

For the 2001 field survey, presence was confirmed in only 121 (42 percent) of the 287 streams surveyed within the SONCC ESU. CDFG (2002) makes two cautions in interpreting their year

2001 results. First, CDFG considered sampling intensity to be sufficient to have a high likelihood of detecting fish for only 110 of the 166 streams where coho salmon were not found. Second, they note that absence of fish in a single year class does not mean that fish have been extirpated from the system.

Scientists at the NOAA Fisheries Southwest Fisheries Science Center compiled a presence-absence database for the SONCC ESU comparable to that developed by CDFG. This dataset is a composite of information contained in the NOAA Fisheries (2001 a) status review update, additional information gathered by NOAA Fisheries since the 2001 status review was published, and data used in the CDFG (2002) analysis. When data were aggregated over complete brood cycles (3-year periods), the percentage of streams for which coho salmon presence was detected remained relatively constant (between 60 percent and 67 percent) between the 1987-1989 and 1996-1998 brood cycles. Percent occupancy for the 1999-2001 brood cycle was lower at 46 percent; however, interpretation of this apparent decline is complicated by two factors. First, the number of streams surveyed was higher than in any other period due to CDFG's intensive survey of the streams listed in Brown and Moyle (1991) in the summer of 2001, a drought year. Second, reporting from the 2002 summer season (brood year 2001) remains incomplete, and as noted above, preliminary data indicate that the 2001 brood year was strong. Thus, it is likely that the percent occupancy for this period will increase after all data from CDFG's 2002 survey and other sources are analyzed. When analysis was restricted to streams on the Brown and Moyle (1991) list, the ESU-wide pattern was almost identical, with percent occupancy values being within 1 percent-2 percent for all time period. Overall, it appears that there has been no dramatic change in the percent of coho salmon streams occupied from the late 1980s and early 1990s to the present.

In general, the number of streams sampled within any individual watershed (or grouping of watersheds) was sufficiently small or variable among time periods to make interpretation of local patterns difficult. However, there are a few noteworthy results for watersheds where sampling frequency is higher. Most notable was coho salmon occurrence within the Eel River basin, which appears to have declined from between 48 percent and 58 percent in the period between 1987 and 1995 to about 30 percent in the past two brood cycles. Similarly, the percentage of streams with coho salmon presence in the Klamath-Trinity system appears to have declined over the five brood cycles examined, though the magnitude of the decrease is smaller. In both these cases, anecdotal reports suggest that inclusion of more data from the 2002 sampling year may increase the observed percentages because of the relatively strong adult returns in the winter of 2001-2002. Still, the relatively low percentage of streams that still support coho salmon in the Eel River and the possible downward trend in the Klamath River basin, despite continued heavy hatchery influence, are cause for concern given that these are the largest river basins in the California portion of the SONCC.

None of the new data available contradict conclusions reached previously by the BRT. Nor do any of recent data (1995 to present) suggest any marked change, either positive or negative, in the abundance or distribution of coho salmon within the SONCC ESU.

b. CCC Coho Salmon

Wild and naturalized coho salmon populations were estimated using the "20-fish rule" (see status review update for Southern OR-Northern CA Coast coho salmon for details) by Brown *et al.* (1994) at 6,160 (47 percent of the statewide total) for the CCC ESU during the late 1980s. All of these estimates are considered to be "best guesses" based on a combination of limited catch statistics, hatchery records, and personal observations of local biologists (Brown *et al.* 1994). Further information regarding status was obtained from Brown *et al.*'s (1994) analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support populations. Of 133 historical coho salmon streams in the CCC ESU for which recent data were available, 62 (47 percent) were determined to still support coho runs while 71 (53 percent) apparently no longer support coho salmon. A subsequent analysis of surveys from 1995-1996 found a somewhat higher (57 percent) percentage of occupied streams (Schiewe 1996a, based on personal communication with P. Adams, NOAA Fisheries Southwest Fisheries Science Center).

CDFG (2002) analyzed presence-absence information in the CCC ESU. Analysis focused on results from CDFG's 2001 summer juvenile sampling effort in which 135 of 173 streams identified by Brown and Moyle (1991) as historical coho salmon streams within the CCC ESU were sampled. For the CCC ESU as a whole, CDFG (2002) estimated that coho salmon were present in 42 percent of streams historically known to contain coho salmon. Estimated occupancy was highest in Mendocino County (62 percent), followed by Marin County (40 percent), Sonoma County (4 percent), and San Francisco Bay tributaries (0 percent). Although the numbers are not directly comparable with those derived by Brown *et al.* (1994), because the specific streams and methods used differ between the two studies, the general regional and overall ESU patterns are similar. The apparent decrease in percent presence in Marin County is likely a function of the increase in number of streams surveyed by CDFG rather than actual extirpations of populations.

Scientists at NOAA Fisheries Southwest Fisheries Science Center recently compiled survey information from streams with historical or recent evidence of coho salmon presence within the CCC ESU. Data were provided primarily by the CDFG, private landowners, consultants, academic researchers, and others who have conducted sampling within the CCC during the years 1988 to 2002. The estimated percentage of streams in which coho salmon were detected shows a general downward trend from 1987 to 2000, followed by a substantial increase in 2001. Several caveats, however, warrant discussion. First, the number of streams surveyed per year also shows a general increase from 1987 to 2000; thus, there may be a confounding influence of sampling size if sites surveyed in the first half of the time period are skewed disproportionately toward observations in streams where presence was more likely. Second, sample size from brood year 2001 was relatively small and the data were weighted heavily toward certain geographic areas (Mendocino County and systems south of the Russian River). The data for brood year 2001 included almost no observations from watersheds from the Navarro River to the Russian River, or tributaries to San Francisco Bay, areas where coho salmon have been scarce or absent in recent years. Thus, while 2001 appears to have been a relatively strong year for coho salmon in the CCC as a whole, the high percentage of streams where presence was detected is likely inflated.

Two other patterns were noteworthy. First, compared with percent presence values for the SONCC ESU, values in the CCC were more highly variable and showed a somewhat more cyclical pattern. In general, percent occupancy was relatively low in brood years 1990, 1993, 1996, and 1999, suggesting that this brood lineage is in the poorest condition. In contrast, during the 1990s, percent occupancy tended to be high in brood years 1992, 1995, 1998, and 2001, suggesting that this is the strongest brood lineage of the three. Second, there is a general tendency for percent occupancy to be slightly higher (2 percent-15 percent) for the streams listed in Brown and Moyle (1991) compared with the ESU as a whole, indicating that the streams in Brown and Moyle (1991) do not constitute a random subset of CCC streams.

When data are aggregated over brood cycles (3-year periods), the percentage of streams with coho salmon detected shows a similar downward trend, from 73 percent in 1987-1989, to 63 percent in 1990-1992, to less than 50 percent in the last three brood cycles. Again there are confounding influences of increased sampling fraction through time and incomplete reporting for the 2001 brood year. Nevertheless, it appears that the percent of historical streams occupied continued to decline from the late 1980s to the mid-1990s and remains below 50 percent for the ESU as a whole. Additionally, coho salmon appear to be extinct or nearing extinction in several geographic areas including the Garcia River, the Gualala River, the Russian River, and San Francisco Bay tributaries. There is also evidence that some populations that still persist in the southern portion of the range, including Waddell and Gazos creeks, have lost one or more brood lineages (Smith 2001).

Results from the BRT presence-absence analysis are generally concordant with CDFG's analysis. The two studies show consistent regional patterns suggesting that within the CCC ESU the proportion of streams occupied is highest in Mendocino County, but that populations in streams in the southern portion of the range (excluding portions of Marin County) have suffered substantial reductions in range. NOAA Fisheries' analysis is more suggestive of a continued decline in percent occupancy from the late 1980s to the present; however, increased sampling in recent years may be confounding any trends.

Coho salmon populations continue to be depressed relative to historical numbers. After considering new information on coho salmon presence within the ESU, the majority of the BRT concluded that the ESU was in danger of extinction, while a minority concluded the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future (Schiewe 1996a).

B. Chinook Salmon

1. Life History and Biological Requirements

Chinook salmon are anadromous and the largest member of ***Oncorhynchus***, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer *et al.* 1983, Page and Burr 1991). Chinook salmon exhibit two main life history strategies: ocean-type fish and river-type fish (Healey 1991). Ocean-type fish typically are fall- or winter-run fish that typically enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, spawn within a few weeks of freshwater entry and have offspring that emigrate shortly after emergence from the redd (Healey 1991). River-type fish are typically spring- or summer-run fish that have a protracted adult freshwater residency, sometimes spawning several months after entering freshwater. Progeny of river-type fish frequently spend one or more years in freshwater before emigrating.

Chinook salmon generally remain in the ocean for two to five years (Healey 1991), and tend to stay along the California and Oregon coasts (NOAA Fisheries 1997a). Some Chinook salmon return from the ocean to spawn one or more years before becoming full-sized adults, and are referred to as jacks (males) and jills (females). Adult fall run CC Chinook salmon typically migrate to coastal streams in northern California from the Russian River to the Klamath River between August and November and spawn shortly thereafter (Myers *et al.* 1998, Fukushima and Lesh 1998). CVSR Chinook salmon typically migrate to the Sacramento River from March to July, and spawn late August to October in the upper reaches of the Sacramento River and principle tributaries.

Egg deposition must be timed to insure that fry emerge during the following spring at a time when the river or estuary productivity is sufficient for juvenile survival and growth. Adult female Chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. Spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 24 cm. Optimal spawning temperatures range between 5.6-13.9°C. Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 1.3-10.2 cm (Allen and Hassler 1986). Embryo survival is strongly correlated with the proportion of substrates in the range of 0.85 mm to 9.50 mm. Survival decreases significantly as the percent of 0.85 mm material increases beyond 10 percent and as 9.50 mm material increases beyond 25 percent (Tappel and Bjornn 1983). Reiser and White (1988) indicated dramatic decreases in survival with fines (<0.84 mm) greater than 10 percent. Geometric mean particle size diameters of 8 mm to 15 mm also result in a marked reduction in survival of Chinook embryos (Shirazi and Seim 1979, Tappel and Bjornn 1983). Minimum intragravel percolation rate depends on flow rate, water depth, and water quality. The percolation rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. The Chinook salmon's need for a strong, constant level of subsurface flow may indicate that suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After depositing eggs in a redd, adult Chinook salmon guard the redd from 4 to 25 days before dying.

Chinook salmon eggs incubate for 90 to 150 days, depending on water temperature. Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 5.6-13.3°C with a preferred temperature of 11.1°C. Fry emergence begins in December and continues into mid-April (Leidy and Leidy 1984). Emergence can be hindered if the interstitial spaces in the redd are not large enough to permit passage of the fry. In laboratory studies, Bjornn and Reiser (1991) observed that Chinook salmon and steelhead fry had difficulty emerging from gravel when fine sediments (6.4 mm or less) exceeded 30-40 percent by volume.

After emergence, Chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks and other areas of bank cover (Everest and Chapman 1972). As they grow larger, their habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. Fish size appears to be positively correlated with water velocity and depth (Chapman and Bjornn 1969, Everest and Chapman 1972). Optimal temperatures for both Chinook salmon fry and fingerlings range from 12-14°C, with maximum growth rates at 12.8°C (Boles 1988). Chinook feed on small terrestrial and aquatic insects and aquatic crustaceans. Cover, in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protect juveniles from predation.

The low flows, high temperatures, and sand bars that develop in smaller coastal rivers during the summer months favor an ocean-type life history (Kostow 1995). With this life history, smolts typically outmigrate as subyearlings during April through July (Myers *et al.* 1998). The ocean-type Chinook salmon in California tend to use estuaries and coastal areas for rearing more extensively than stream-type Chinook salmon. The brackish water areas in estuaries moderate the physiological stress that occurs during parr-smolt transitions.

2. <u>Status of Stocks</u>

a. CC Chinook

Primary causes for concern in the CC Chinook salmon ESU are low abundance, reduced distribution (particularly in the southern portion of the ESU's range), and generally negative trends in abundance; all of these concerns are especially strong for spring-run Chinook salmon in this ESU (Myers *et al.* 1998). Previous reviews of conservation status for Chinook salmon in this area exist. Nehlsen *et al.* (1991) identified three putative populations (Humboldt Bay Tributaries, Mattole River, and Russian River) as being at high risk of extinction and three other populations (Redwood Creek, Mad River, and Lower Eel River) as being at moderate risk of extinction. Higgins *et al.* (1992) identified seven "stocks of concern," of which two populations (tributaries to Humboldt Bay and the Mattole River) were considered to be at high risk of extinction.

Natural populations of Chinook salmon in the Russian River may no longer exist. No long-term, continuous time series are available for sites in the Russian River basin, but sporadic estimates based on spawner surveys are available for some tributaries. Video-based counts of upstream migrating adult Chinook salmon passing a temporary dam near Mirabel on the Russian River are available for 2000-2002. Counts are incomplete, due to technical difficulties with the video apparatus, occasional periods of poor water clarity, occasional overwhelming numbers of fish, and disparities between counting and migration periods; thus, these data represent a minimum count of adult Chinook. Counts have exceeded 1,300 fish in each of the last three years (5,465 in 2002); and a rigorous mark-recapture estimate of outmigrant abundance in 2002 exceeded 200,000 (Shawn Chase, Sonoma County Water Agency, personal communication, 2003).

Few new data, and few new datasets for the CC Chinook ESU are available for consideration, and none of the recent data contradict the conclusions of previous status reviews.

b. *CVSR Chinook salmon*

The Central Valley spring-run Chinook salmon ESU has had the most dramatic decline of the four Chinook salmon runs in the Central Valley (Campbell and Moyle 1990, Fisher 1994). The main threats to spring-run Chinook salmon include loss of most historic spawning habitat, degradation of remaining habitat, and genetic threats from the Feather River Hatchery of spring-run Chinook salmon program (NOAA Fisheries 2003). The majority of the large populations of spring-run Chinook salmon in the Central Valley has been extirpated and the remaining populations have been significantly reduced (Campbell and Moyle 1990). Spring-run Chinook salmon have displayed broad fluctuations in abundance, ranging from lows of 426 in 1966 and 3,044 in 1992 to highs of 27,890 in 1982 and 33,771 in 1998.

Historically, spring-run Chinook salmon were predominant throughout the Central Valley, occupying the upper and middle reaches of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit Rivers, with smaller populations in other tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). In the late 1940's, spring-run Chinook salmon were extirpated from the upper San Joaquin River, and only remnant populations persisted in the San Joaquin basin through the 1950's.

Spring-run Chinook salmon are currently restricted to the Sacramento River drainage. Hybridization with fall-run Chinook salmon in several Sacramento Valley streams threaten their ability to remain a distinct race in the mainstem Sacramento River (Slater 1963). For example, based on coded wire tag identifications, nearly a quarter of returning spawners to the Feather River Hatchery were spring-fall hybrids (CDFG, unpublished data). Self-sustaining wild populations of spring-run Chinook salmon occur only in Mill, Deer, and Butte Creeks in the

Sacramento River drainage, and remain vulnerable to extirpation (NOAA Fisheries 2003). Abundance data for Mill, Deer, Butte, and Big Chico creek spring-run Chinook salmon have been updated through 2001, and show that the increases in population that started in the early 1990s has continued. During this period, there have been significant habitat improvements (including the removal of several small dams and increases in summer flows) in these watersheds, as well as reduced ocean fisheries and a favorable terrestrial climate (NOAA Fisheries 2003).

C. Steelhead

1. Life Historv and Biological Requirements

Steelhead spend anywhere from one to five years in saltwater, however, two to three years are most common (Busby *et al.* 1996). Some return as "half-pounders" that over-winter one season in freshwater before returning to the ocean in the spring. The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986).

Steelhead can be divided into two reproductive ecotypes, based upon their state of sexual maturity at the time of river entry and the duration of their spawning migration: stream maturing and ocean maturing. Stream maturing steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn; whereas ocean maturing steelhead enter fresh water with well developed gonads and spawn shortly after river entry. These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (i.e., summer [stream maturing] and winter steelhead [ocean maturing]). Adult summer steelhead typically oversummer in pools. Freshwater distribution of adult summer steelhead is affected by pool dimension, amount and type of cover, and water temperature (Reviewed in Nakamoto 1994, Nielsen *et al.* 1994, Baigun *et al.* 2000). Only winter steelhead are found in the CCC steelhead ESU, whereas both winter and summer steelhead are found in the NC steelhead ESU.

Busby *et al.* (1996) and Fukushima and Lesh (1998) document immigration timing for winter and summer steelhead throughout the action area. Typically, adult winter steelhead immigrate from September through June, while adult summer steelhead immigrate from March through September. Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). The preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972, Smith 1973).

Most spawning takes place from January through April. Steelhead may spawn more than one season before dying (iteroparity), in contrast to other species of the *Oncorhynchus* genus. Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Among repeat spawners, the representation of each group declines as the number of spawnings increases. There is a sharp decline in numbers from second spawners (15.0 percent) to third spawners (2.1 percent). Fish spawning four or more times are rare (0.1 percent). Steelhead usually spawn in the tributaries where fish ascend as high as flows permit (United States Army Corps of Engineers 1982).

Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times (CDFG 1997). Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in freshwater before emigrating downstream. Emigration appears to be more closely associated with size than age. In Waddell Creek, Shapovalov and Taft (1954) found steelhead juveniles migrating downstream at all times of the year with the largest numbers of age 0+ and yearling steelhead moving downstream during spring and summer. Smolts can range from 14-21 cm in length.

Steelhead spawn in cool, clear streams featuring suitable water depth, gravel size, and current velocity. Intermittent streams may be used for spawning (Everest 1973, Barnhart 1986). Reiser and Bjornn (1979) found that gravels of 1.3-11.7 cm in diameter and flows of approximately 4 cfs were preferred by steelhead. The survival of embryos is reduced when fines of less than 6.4 mm comprise 20-25 percent of the substrate. Studies have shown a higher survival of embryos when intragravel velocities exceed 20 cm/hr (Coble 1961, Phillips and Campbell 1961). The number of days required for steelhead eggs to hatch is inversely proportional to water temperature and varies from about 19 days at 15.6°C to about 80 days at 5.6°C. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Older fry establish territories which they defend. Cover is an important habitat component for juvenile steelhead both as velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Steelhead however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, they become inactive and hide in any available cover, including gravel or woody debris.

Water temperature influences the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles (Barnhart 1986, Bjornn and Reiser 1991). Rearing steelhead juveniles prefer water temperatures of 7.2-14.4°C and have an upper lethal limit of 23.9°C. They can survive up to 27°C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al.* 1996).

Dissolved oxygen (DO) levels of 6.5-7.0 mg/l affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al.* 1963). Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. Low DO levels decrease the rate of metabolism, swimming speed, growth rate, food consumption rate, efficiency of food utilization, behavior, and ultimately the survival of the juveniles.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

2. Status of Stocks

a. NC steelhead

Busby *et al.* (1996) provides a comprehensive review of estimates of historic abundance, decline and present status of steelhead in western United States. They reviewed previous assessments within this ESU that identified several stocks as being at risk or of special concern. Nehlson *et al.* (1991) identified three stocks as at risk of extinction: summer steelhead in Redwood Creek, Mad River, and Eel River. Higgins *et al.* (1992) provided a more detailed analysis of some of these stocks and identified 11 summer steelhead stocks as at risk or of concern.

Estimates of historical (pre-1960s) abundance specific to this ESU were available from dam counts in the upper Eel River (Cape Horn Dam--annual average of 4,400 adult steelhead in the 1930s; McEwan and Jackson 1996), the South Fork Eel River (Benbow Dam--annual average of 19,000 adult steelhead in the 1940s; McEwan and Jackson 1996), and the Mad River (Sweasey Dam--annual average of 3,800 adult steelhead in the 1940s; Murphy and Shapovalov 1951, CDFG 1994). In the mid-1960s, CDFG (1965) estimates steelhead spawning populations for many rivers in this ESU totaled 198,000. Estimated total run size for the major stocks in California (entire state) for the early 1980s was given by Light (1987) as approximately 275,000. Of these, 22 percent were of hatchery origin, resulting in a naturally produced run size of 215,000 steelhead. Roughly half of this production was thought to be in the Klamath River Basin (including the Trinity River), so the total natural production for all ESUs south of Punta Gorda was probably on the order of 100,000 adults. The only current run-size estimates for this area are counts at Cape Horn Dam on the Eel River where an average of 115 total and 30 wild adults were reported (McEwan and Jackson 1996). Although there is no estimate of total abundance for this ESU, steelhead appear widely distributed throughout the region.

Busby *et al.* (1996) computed adult escapement trends for seven stocks within this ESU. Of these, five data series exhibit declines and two exhibit increases during the available data series, with a range from 5.8 percent annual decline to 3.5 percent annual increase. Three of the declining trends were significantly different from zero. For one long data set (Eel River, Cape Horn Dam counts), a separate trend for the last 21 years (1971-91) was calculated for comparison: while the full-series trend showed significant decline, the recent data showed a lesser, nonsignificant decline, suggesting that the major stock decline occurred prior to 1970. There has been little change in Northern California steelhead ESU status recently. Adams (2000) states that trend numbers have shown small increases, but there are no substantial changes in abundance of NC steelhead.

Hatchery fish are widespread and escaping to spawn naturally throughout the region. According to McEwan and Jackson (1996, p. 37), "despite the large number of hatchery smolts released, steelhead runs in north coast drainages are comprised mostly of naturally produced fish." We have little information on the actual contribution of hatchery fish to natural spawning, and little information on present total run sizes for this ESU. However, given the preponderance of significant negative trends in the available data, there is concern that steelhead populations in this ESU may not be self-sustaining. The major present threat to genetic integrity for steelhead in this ESU comes from past and present hatchery practices. Within this ESU, we have no information regarding spatial or temporal separation of spawning hatchery and natural fish, but there is probably sufficient overlap for some genetic introgression to occur.

b. CCC Steelhead

Only two estimates of historic (pre-1960s) abundance specific to this ESU are available: an average of about 500 adults in Waddell Creek in the 1930s and early 1940s (Shapovalov and Taft 1954), and 20,000 steelhead in the San Lorenzo River before 1965 (Johnson 1964). In the mid-1960s, 94,000 adult steelhead were estimated to spawn in the rivers of this ESU, including 50,000 fish in the Russian River and 19,000 fish in the San Lorenzo River (CDFG 1965).

The original BRT concluded that the ESU was in danger of extinction (Busby *et al.* 1996). Extirpation was considered especially likely in Santa Cruz County and in the tributaries of San Pablo and San Francisco Bays. The BRT suggested that abundance in the Russian River (the largest system inhabited by the ESU) has declined seven-fold since the mid-1960s, but abundance appeared to be stable in smaller systems. Two major sources of uncertainty were: 1) few data on run sizes, which necessitated that the listing be based on indirect evidence, such as habitat degradation; and 2) genetic heritage of populations in tributaries to San Francisco and San Pablo Bays was uncertain, causing the delineation of the geographic boundaries of the ESU to be uncertain. A status review update (Schiewe 1997) concluded that conditions had improved slightly, and that the ESU was not presently in danger of extinction, but was likely to become so in the foreseeable future. (Minorities supported both more and less extreme views on extinction risk.). Uncertainties in the update mainly revolved around inadequate sampling methods for estimating adult and juvenile numbers in various basins.

Recent estimates indicate an abundance of about 7,000 adult steelhead in the Russian River and about 500 fish in the San Lorenzo River. These estimates suggest that recent total abundance of steelhead in these two rivers is less than 15 percent of their abundance in the mid 1960s. Recent estimates for several other streams (Lagunitas Creek, Waddell Creek, Scott Creek, San Vincente

Creek, Soquel Creek, and Aptos Creek) indicate individual run sizes of 500 fish or less. Steelhead in most tributaries to San Francisco and San Pablo bays have been virtually extirpated (McEwan and Jackson 1996). Fair to good runs of steelhead still apparently occur in coastal Marin County tributaries. In a 1994 to 1997 survey of 30 San Francisco Bay watersheds, steelhead occurred in small numbers at 41 percent of the sites, including the Guadalupe River, San Lorenzo Creek, Corte Madera Creek, and Walnut Creek (Leidy 1997). While there are several concerns with these data (e.g., uncertainty regarding origin of juveniles), NOAA Fisheries believes it is generally a positive indicator that there is a relatively broad distribution of steelhead in smaller streams throughout the region.

Recent data for the Russian and San Lorenzo Rivers (e.g., CDFG 1994, Reavis 1991) suggested that these basins had populations smaller than 15 percent of the size that they had 30 years previously. These two basins were thought to have originally contained the two largest steelhead populations in the ESU.

Little information is available regarding the contribution of hatchery-produced fish to natural spawning of steelhead, and little information on present run sizes or trends for this ESU exists. However, given the substantial rates of declines for stocks where data do exist, the majority of natural production in this ESU is likely not self-sustaining (62 FR 43937).

c. SCCC steelhead

Data on this ESU are sparse. In the mid 1960s, the CDFG (1965) estimated that the ESU-wide run size was about 17,750 adults. Many of the streams have somewhat to highly impassable barriers, both natural and anthropogenic, and in their upper reaches, harbor populations of resident trout. The relationship between anadromous and resident *O. mykiss* is poorly understood in this ESU, but likely plays an important role in its population dynamics and evolutionary potential. A status review update conducted in 1997 (Schiewe 1997) listed numerous reports of juvenile *O. mykiss* in many coastal basins; but noted that the implications for adult numbers were unclear. The two largest river systems in this ESU—the Pajaro and Salinas basins—are much degraded and have steelhead runs much reduced in size. These two large systems are ecologically distinct from the populations in the Big Sur area and San Luis Obispo County, and thus, their degradation affects spatial structure and diversity of the ESU.

In 2002, an extensive study was made of steelhead occurrence in most of the coastal drainages between the northern and southern geographic boundaries of the ESU (David Boughton, NOAA Fisheries, personal communication, November 2003). Steelhead were considered to be present in a basin if adult or juvenile *O. mykiss* were observed in stream reaches that had access to the ocean (i.e., no impassable barriers between the ocean and the survey site), in any of the years 2000-2002 (i.e., within one steelhead generation). Of 37 drainages in which steelhead were known to have occurred historically, between 86 percent and 95 percent were currently occupied by *O. mykiss*. The range in the estimate of occupancy occurs because three basins could not be assessed due to restricted access. Of the vacant basins, two were considered to be vacant because they were dry in 2002, and one was found to be watered but a snorkel survey revealed no *O. mykiss*. One of the "dry" basins—Old Creek—is dry because no releases were made from Whale Rock Reservoir; however, a land-locked population of steelhead is known to occur in the reservoir above the dam (NOAA Fisheries 2003).

Occupancy was also determined for 18 basins with no historical record of steelhead occurrence. Three of these basins—Los Osos, Vicente, and Villa Creeks—were found to be occupied by *O. mykiss*. It is somewhat surprising that no previous record of steelhead seems to exist for Los Osos Creek, near Morro Bay and San Luis Obispo. The current distribution of steelhead among the basins of the region is not much less than what occurred historically. This conclusion rests on the assumption that juveniles inhabiting stream reaches with access to the ocean will undergo smoltification and thus are truly steelhead.

Data available for the Carmel River are the only time-series available for this ESU. These data suggest that the abundance of adult spawners in the Carmel River has increased since the last status review. Continuous data has been collected for the period 1988 through 2002. The beginning of this time series has counts of zero adults for three consecutive years, then shows a rapid increase in abundance. The time series is too short to infer anything about the underlying dynamic cause of the positive trend. It is possible that the trend arises from immigration of adults (or the planting ofjuveniles) from other areas; in particular, from the lower reaches of the Carmel River below San Clemente dam. The rapid increase in adult abundance from 1991 (one adult) to 1997 (775 adults) seems great enough to require substantial immigration or transplantation as an explanation. While steelhead populations in the Carmel River appear to be increasing the effects of the drought in the 1980s, the current dependence of the population on intensive management of the river system, and the vulnerability of the population to future droughts continue to be cause for concern in the Carmel River.

*d. **CV steelhead***

Central Valley steelhead once ranged throughout most of the tributaries and headwaters of the Sacramento and San Joaquin basins prior to dam construction, water development, and watershed perturbations of the 19th and 20th centuries (McEwan and Jackson 1996). Steelhead counts at the Red Bluff Diversion Dam (RBDD) in the upper Sacramento River declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990's (McEwan 2001). Recent estimates from trawling data in the San Francisco-San Joaquin Delta suggest estimates of over 3,600 female steelhead spawn in the Central Valley basin (NOAA Fisheries 2003).

Existing wild steelhead stocks in the Central Valley are mostly confined to upper Sacramento River and its tributaries, including Antelope, Deer, Mill Creeks, and American, Feather and Yuba Rivers (McEwan and Jackson 1996). Naturally spawning populations are known to occur in Butte Creek, and the upper Sacramento, Feather, American, and Stanislaus Rivers (CALFED Bay-Delta Program 2000). Until recently, steelhead were thought to be extirpated from the San

Joaquin River system. Recent monitoring has detected self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void of steelhead (McEwan 2001). The lack of monitoring programs unfortunately limits the ability to detect naturally spawning populations that may be present in other tributaries (Interagency Ecological Program Steelhead Project Work Team 1999).

IV. ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

The action area includes a large portion of each ESU considered in this consultation. We primarily describe the environmental baseline on an ESU-scale. However, we also present focused information on certain watersheds where proposed projects may have a greater impact on local populations based on current information on the population's status.

A. Description of the Action Area

The action area includes all coastal California streams north of the Santa Maria River in San Luis Obispo County north to the Oregon/California border and streams draining into San Francisco and San Pablo bays, including the Sacramento-San Joaquin River Basin.

B. Factors Affecting the Environment Within the Action Area

NOAA Fisheries cites many reasons (primarily anthropogenic) for the decline of coho salmon (Weitkamp *et al.* 1995), Chinook salmon (Myers *et al.* 1998), and steelhead (Busby *et al.* 1996). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat. Additional factors contributing to the decline of these populations include: commercial and recreational harvest, ocean conditions, predation, natural stochastic events, and water quality. Scientific research and habitat restoration activities may affect anadromous salmonid populations within the action area, but have not been specifically identified as factors contributing to the decline of these populations.

Many of the biological requirements for anadromous salmonids in the action area can best be expressed in terms of the essential features of their habitat. That is, they require adequate: (1) substrate (especially spawning gravel), (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) migration conditions. The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids by adversely affecting these essential habitat features.

We describe factors affecting the ESUs within the action area separately for Coastal streams and Central Valley streams to emphasize the difference in the role of the factors in the two regions.

1. Coastal Streams

In this section, we discuss specific, followed by general risk factors for listed salmonids inhabiting coastal streams in the action area.

CCC coho salmon. Currently, the main risk factors for CCC coho salmon include extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity. Additionally, the main stocks of coho salmon in the CCC ESU have been heavily influenced by hatcheries and there are relatively few native coho salmon left in the ESU (Weitkamp *et al.* 1995). Most existing stocks have a history of hatchery planting, with many out-of-ESU stock transfers. A subsequent status review (Schiewe 1996b), which focused on existing hatcheries, concluded that, despite the historical introduction of non-native fish, the Scott Creek (Kingfisher Flat) and Noyo River brood stocks have regularly incorporated wild broodstock and, thus, are unlikely to differ from naturally spawning fish within the ESU. Recent droughts and unfavorable ocean conditions have also been identified as natural factors contributing to reduced run size (NOAA Fisheries 2003).

SONCC coho salmon. No new information has been provided that suggests risks beyond those identified in previous status reviews for SONCC coho salmon. Termination of hatchery production of coho salmon at the Mad River and Rowdy Creek facilities has eliminated potential adverse risks associated with hatchery releases from these facilities. Likewise, restrictions on recreational and commercial harvest of coho salmon since 1994 have likely had a positive impact on coho salmon adult returns to SONCC streams (NOAA Fisheries 2003).

CCC steelhead. Within the CCC steelhead ESU, two significant habitat blockages are the Coyote and Warm Springs Dams in the Russian River watershed; data indicated that other smaller fish passage problems were widespread in the geographic range of the ESU. Other impacts to this ESU include: urbanization and poor land-use practices; catastrophic flooding in 1964 causing habitat degradation; and dewatering due to irrigation and diversion. Principal hatchery production in the region comes from the Warm Springs Hatchery on the Russian River, and the Monterey Bay Salmon and Trout Project on a tributary of Scott Creek (NOAA Fisheries 2003).

NC steelhead. The previous status review (Busby *et al.* 1996) identified two major barriers to fish passage in the NC steelhead ESU: Mathews Dam on the Mad River and Scott Dam on the Eel River. Numerous other blockages on tributaries were also thought to occur. Poor forest practices and poor land use practices, combined with catastrophic flooding in 1964, were thought to have caused significant declines in habitat quality that then persisted up to the date of the status review. These effects include sedimentation and loss of spawning gravels. Non-native Sacramento pikeminnow (*Ptychocheilusgrandis*) had been observed in the Eel River Basin and could potentially be acting as predators on juvenile steelhead (NOAA Fisheries 2003).

SCCC ***steelhead.*** Risk factors in the SCCC steelhead ESU include the presence of numerous minor habitat blockages likely throughout the region; habitat degradation; and dewatering from irrigation and urban water diversions. Many of the streams have somewhat to highly impassable barriers, both natural and anthropogenic, and in their upper reaches, harbor populations of resident trout (NOAA Fisheries 2003).

CC ***Chinook.*** Previous status reviews considered the following to pose significant risks to the CC Chinook Salmon ESU: degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, mining, and severe recent flood events (exacerbated by land use practices). Special concern was noted regarding the more precipitous declines in distribution and abundance in spring-run Chinook salmon. Many of these factors are particularly acute in the southern portion of the ESU range and were compounded by uncertainty stemming from the general lack of population monitoring in California (Myers *et al.* 1998).

There are two watersheds of northern California coastal ESUs where numerous research projects have occurred in the past, or are proposed, and therefore warrant further detail: Redwood Creek and Freshwater Creek. These projects include those proposed for exemption under 4(d) rules or authorized by section 10(a)(1)(A) permits. These watersheds are attractive to researchers because they both have adequate populations of salmon and steelhead to support projects, they are close to Humboldt State University and local offices of U. S. Fish and Wildlife Service and CDFG, the watersheds are made up of largely publicly owned lands or have cooperative land owners, and, in the case of Freshwater Creek, there is an active volunteer group involved the watershed's monitoring and restoration programs. Most all of the same myriad of anthropogenetic activities that have negatively impacted salmonid habitat through out the action area have also impacted the Redwood Creek and Freshwater Creek watersheds. What follows is a brief description of environmental baseline descriptions for these watersheds.

Redwood ***Creek.*** The Redwood Creek watershed is located in the Northern Coast Range of California. Redwood Creek flows into the Pacific Ocean near Orick. The drainage area at the stream mouth is about 285 square miles. The basin is narrow and elongated, with its long axis oriented northwest-southeast. The total length of the basin is about 65 miles, and its width varies from 4 to 7 miles. Total basin relief is about 5,300 feet, with a mean annual basin-wide precipitation of approximately 80 inches.

Timber harvesting is the most widespread land use in Redwood Creek basin. Over 85 percent of the basin upstream of Redwood National Park has been logged, including about 30 percent which was logged between 1978-1992. About 1,200 miles of forest roads and 5,400 miles of skid trails were built within the Redwood Creek watershed as of 1978. Recent surveys located about 1,200 sites with potential or existing erosional problems along old haul roads in the Park. In addition, about 20 miles of state highway and county roads cross the watershed, including several miles of abandoned state highway. However, since 1981, former log-haul roads have been the primary focus of the watershed restoration efforts within Redwood National Park. About 175 miles of logging roads have been treated since 1978.

Salmonid habitat in the lower portions of Redwood Creek, including the estuary, has been degraded by the flood control levees, which were built by the U.S. Army Corps of Engineers in 1968. The levee bisects the estuary at the mouth of Redwood Creek and drastically impairs the physical and biological functions of the estuary and adjacent wetlands, confining the Redwood Creek channel to a width of 300 feet for a length of 3.4 miles. Mining within the Redwood Creek watershed has been limited to gravel mining within the channel of Redwood Creek and rock quarries and borrow pits used for road construction. Gravel has been mined between the flood-control levees on Lower Redwood Creek, near the mouth of Prairie Creek, at the mouth of Tom McDonald Creek, and near Highway 299.

Although currently improving, the loss of canopy closure in the upper Redwood Creek basin due to removal of streamside trees has contributed to high water temperatures in the mainstem. Limited information is available concerning large woody debris within the riparian management zone in Redwood Creek. Due to harvesting of riparian forests along Redwood Creek and its tributaries along with streambank erosion, recruitment of LWD is well below historic levels, which diminishes the amount of rearing habitat available to juvenile salmonids. This condition is likely to persist into the future as deciduous willows and alders take the place of evergreen conifers along much of the mainstem and tributaries.

Channel deposition has destroyed much of the pool/riffle configuration of the creek, drastically reducing rearing habitat for fish. Although channel deepening and pool development have been observed in all but the lower few miles of the creek, the mainstem generally lacks an adequate pool-riffle structure and cover. Redwood Creek's ability to support fish populations is determined by habitat availability and quality. Habitat availability is limited by, among other things, physical barriers such as boulders, debris jams, dams, culverts, and dewatered stream segments caused by aggradation (rising stream bed elevation).

SONCC coho salmon, CC Chinook salmon, and NC steelhead in Redwood Creek are much reduced in comparison to historic accounts. Available adult survey data from Redwood Creek and its tributaries suggest that yearly adult population numbers for both SONCC coho salmon and CC Chinook salmon number in the hundreds to perhaps a few thousand. Documented escapement numbers of adult coho salmon in Prairie Creek (a tributary of Redwood Creek) for the years 1999-2002 are 69, 53, 252, and 363 individuals for each year respectively. Based upon mark and recapture efficiency rates, CDFG estimated the number of 0+ Chinook salmon leaving upper Redwood Creek in 2002 at 518,189, compared with 378,063 in 2001 and 427,542 in 2000.

Surveys of NC steelhead suggest that their yearly adult population numbers fall within the range of hundreds of individuals. Based upon mark and recapture efficiency rates, CDFG estimated the number of 1+ steelhead leaving upper Redwood Creek in 2002 at 28,501, compared with 50,654 in 2001 and 68,328 in 2000. Approximately 7,370 2+ steelhead outmigrated in 2002, compared with 12,668 in 2001 and 4,739 in 2000.

Freshwater Creek. The Freshwater Creek watershed is a 31 square mile drainage basin located approximately five miles east of Eureka, in Humboldt County, California. Major land uses in the watershed are forestry (91 percent of the watershed area), agricultural/ residential (8 percent), and power line right-of-way (1 percent).

Freshwater Creek is listed under section 303(d) of the Clean Water Act as water quality limited due to excess sediment. Freshwater Creek has also been listed by the California Department of Forestry as cumulatively affected by excess sediment. Excess sediment generated and mobilized in Freshwater Creek will ultimately impact habitat in the action area through filling due to siltation, and seasonal reductions in water quality during storm generated runoff.

Since the late 1800s rural residential and urban development have been concentrated in the lower elevation hills and areas that transition from hillslopes into valley bottoms above flood plains and former estuarine areas. Due to gradual subdividing and infilling of former farm properties, the rural character of area has been replaced by a more suburban setting containing sprawling homes, modern commercial properties, mobile home courts, and at least one "custom home" park.

The Freshwater Community Plan contains the premise that no major water or sewer extensions will be made in the foreseeable future due to lack of support by the planning area's residents. The North Coast Regional Water Quality Control Board's (RWQCB) adoption of a "waiver prohibition area" in the Humboldt Bay area requires strict adherence to the RWQCB's septic tank criteria with no variance allowed. The waiver prohibition has made septic tank permits more difficult to obtain in the planning area. This prohibition will likely result in a less housing development in the Freshwater Watershed and a corresponding decrease in adverse affects to salmonids associated with urbanization.

Hatchery plants of coho salmon by the Humboldt Fish Action Council (HFAC) in Freshwater Creek ceased in 1995, but Chinook salmon supplementation has continued. The HFAC hatchery program for Freshwater Creek may be inflating adult Chinook salmon and coho salmon returns in some years since 1978.

From 1986 through 1999, between 0 (1997) and 91 (1987) CC Chinook salmon adults were counted during spawner surveys; in five of the nine years the number was less than 10. In these same years, the number of NC steelhead counted ranged between 0 and 27, in seven of the nine years the number was 2 or less. The number of SONCC coho salmon adults counted in spawner surveys ranged from 602 (1987) to 0 in 1998. Between 1992 and 2000, adult coho salmon trapped at the fish weir on Freshwater Creek has ranged from less than 50 (1998) to between 100 and 200 (1992, 1995,1997, 1999, 2000) with a peak of 500+ in 1996. Since 2000, the number of returning adult salmonids to Freshwater Creek has increased. In 2001-2002 707 SONCC coho salmon, 122 CC Chinook salmon, and 76 NC steelhead were trapped at the Freshwater Creek fish weir; in 2002-2003, 459 SONCC coho salmon, 71 CC Chinook salmon, and 91 NC steelhead (Seth Ricker, CDFG, Pers. Comm.) Based on mark and recapture data, an estimated 1500 adult SONCC coho salmon returned to the watershed.

In Freshwater Creek, coho salmon are found in each of the sub-basins, with the possible exception of School Forest, up to the point where either natural barriers or increasing stream gradient limits their distribution. The highest densities of coho salmon can be found in the lower reaches of Cloney Gulch, Upper Freshwater, McCready Gulch, and possibly the mid- to lower mainstem of Freshwater Creek. Steelhead are found in each of the sub-basins, with the possible exception of School Forest, up to the point where either natural barriers or increasing stream gradient limits their distribution. Steelhead are most common in Upper Freshwater Creek. In the Freshwater Creek basin, Chinook salmon tend to be found primarily in lower and middle portions of the mainstem of Freshwater Creek and lower portions of South Fork Freshwater Creek where significant deposits of coarse gravel are found.

a. Agriculture

Agricultural practices have contributed to the degradation of salmonid habitat on the West Coast through irrigation diversions, overgrazing in riparian areas, and compaction of soils in upland areas from livestock (reviewed in 61 FR 56138.) These practices have also altered the natural flow patterns of streams and rivers within the action area. Early agricultural practices have resulted in filled sloughs and side channels and removed riparian vegetation. River valleys have been leveled and water courses channelized, altering drainage and runoff patterns. Agricultural operations removed riparian vegetation, small in-channel islands, and gravel bars to increase arable acreage and achieve flood control.

Vegetation removal and channel destabilization has accelerated erosion. In response to increased erosion, bank stabilization measures began and continued as cultivated acreage increased. Stabilization measures increased channel straightening which expedited channel downcutting. In addition to changing river morphology, agricultural practices decrease water quality by releasing fertilizers and pesticides into streams and rivers (Florsheim and Goodwin 1993). Enrichment from manures is also a problem where barns and livestock are adjacent to watercourses. Maahs *et al.* (1984) reported that the largest diffuse source of water quality degradation comes from agriculture-derived contaminants such as sediment, nutrients and pesticides (reported in Osborne and Kovacic (1993)).

Grazing activities in coastal watersheds have resulted in loss of native perennial grasses and riparian vegetation; soil loss; hillside trailing and gullying; and the incision of swales and meadows. Soils compacted by overgrazing on land with minimal vegetative cover have significantly reduced infiltration rates. Instead of the water moving into the soil it moves rapidly over it, delivering heavy runoff to streams, which in turn can result in flashy watersheds (Kohler and Hubert 1993). This altered cycle is characterized by reduced groundwater storage capacity, and a greater propensity for intermittent stream flow during low flow periods. The response within the stream corridor is one of bank erosion, channel scour, and loss of riparian and fish habitat.

The vigor, composition and diversity of natural vegetation can be altered by livestock grazing in and around riparian areas. This in turn can affect the site's ability to control erosion, provide stability to stream banks, and provide shade, cover, and nutrients to the stream. Mechanical compaction can reduce the productivity of the soils appreciably and cause bank slough and erosion. Mechanical bank damage often leads to channel widening, lateral stream migration, and excess sedimentation. (Reviewed in 61 FR 56138.)

b. Forestry

Forestry practices have limited production of anadromous salmonids and affected their habitat in many ways. Habitat degradation by forestry activities has mostly occurred in tributaries, which mostly affects spawning and early-rearing juvenile salmonids. Populations are limited in tributary and mainstem habitats by the loss of large woody debris, debris barriers, increased temperatures, massive siltation, loss of riparian cover diversity, road building and maintenance causing increased sedimentation of fines and the filling of pools. Bilby and Bisson 1998 (as reported in Standiford and Arcilla 2001) stated that large woody debris in Northern California streams has generally decreased over the last century due to forestry practices. The loss of large woody debris affects fish in that there is less habitat complexity, less deposition of sediment, less deposition of fine organic matter that feeds stream invertebrates, and fewer pool forming elements.

Forestry practices have also affected salmonid habitat by the removal of streamside vegetation, accelerating erosion, the introduction and removal of organic debris, and altering the shape of the channel (Chamberlin 1982). The removal of riparian vegetation along the channel from logging activities can result in increased stream temperatures (Beschta *et al.* 1987). These temperature changes can impact salmonids by influencing factors such as rates of egg development, rearing success and species competition and increase their susceptibility to diseases. Increased erosion can occur as a result of forestry activities. Site disturbance and road construction typically increase sediment delivery to streams through mass wasting and surface erosion, which can elevate levels of fine sediment in spawning gravels and fill pool habitats used by salmonids for rearing (Spence *et al.* 1996).

The effects of introducing organic debris can be positive in that organic debris controls sediment transport and provides habitat for aquatic organisms (Swanson and Lienkaemper 1978, Keller and Swanson 1979, Bryant 1980), however, the introduction of excessive amounts can impede fish movement and reduce dissolved oxygen levels (Hall and Lantz 1969). Logging activities can also lead to morphological changes in the channel due to increased sediment inputs (Reid

1994). These changes include the widening and increased braiding of some streams and the filling in of pools. When flows on these streams spread too widely, upstream migration of adults is hindered. The loss of pools decreases available habitat for salmonids and removes cool water refuges needed for summer survival in some streams.

Timber harvest related activities in the past have had more impact across forested ecosystems than current timber practices, especially those that employed ground-based equipment methods just after World War II. The majority of private and state timber land holdings within the Coastal action area have been harvested, leading to a decrease in habitat quality for salmonids. Also, the removal of riparian trees during timber harvesting activities reduces shading and recruitment of organic debris important in maintaining salmonid habitats (Spence *et al.* 1996). Past timber harvest and to some extent ongoing timber harvest activities along many streams within the Coastal action area have contributed to decreases in wild populations of anadromous salmonids over time.

c. Urban Development

Urbanization has degraded anadromous salmonid habitat through stream channelization, flood plain drainage, and riparian damage (reviewed in 61 FR 56138). When watersheds are urbanized, problems may result simply because structures are placed in the path of natural runoff processes, or because the urbanization itself has induced changes in the hydrologic regime. In almost every point that urbanization activity touches the watershed, point source and nonpoint pollution occurs. Sources of nonpoint pollution, such as sediments washed from the urban areas, contain trace metals such as copper, cadmium, zinc, and lead (California State Lands Commission 1993). These, together with pesticides, herbicides, fertilizers, gasoline, and other petroleum products, contaminate drainage waters and harm aquatic life necessary for anadromous salmonid survival. Water infiltration is reduced due to extensive ground covering. As a result, runoff from the watershed is flashier, with increased flood hazard (Leopold 1968). Flood control and land drainage schemes may concentrate runoff, resulting in increased bank erosion which causes a loss of riparian vegetation and undercut banks and eventually causes widening and down-cutting of the stream channel.

Florsheim and Goodwin (1993) found that as urban centers develop, there was an initial influx of sediment into streams from erosion, followed by an increase in runoff from the large areas of concrete and asphalt once building is complete. This resulted in increased flooding and stream bank erosion, to which the frequent human response was stream channelization, particularly on tributaries. Steiner Environmental Consulting (1996) was concerned that roads may pose the greatest threat of urbanization to streams. They concluded that road construction and unpaved roads caused significant direct sediment input to streams, i.e., poorly designed road cuts and inadequate grading maintenance frequently resulted in hillslope failure.

As human population expanded, demand for gravel and water increased proportionately, resulting in altered stream channels and degraded habitat, either directly or through cumulative negative impacts to the river system (Steiner Environmental Consulting 1996). Florsheim and Goodwin (1993) determined that stream pollution increased with higher human density, degrading water quality for both people and wildlife. Increased water demands and unscreened diversions threaten newly emerged fry (Steiner Environmental Consulting 1996).

Roads, bridges, and residential development located in flood plains have historically been supported by an ongoing process of channel maintenance to protect the existing infrastructure. These channel maintenance activities include removal of large woody debris, armoring of stream banks with rip-rap, construction of gabions and engineered bank stabilization structures, diking and rechanneling of natural stream channels. Although many of these activities have been scaled back or curtailed in recent years, the effects of these activities are still influencing salmonid populations within the basin.

Urbanization has been a major influence on the land surrounding the San Francisco Bay Estuary. In the past 150 years, the diking and filling of tidal marshes have decreased the surface area of San Francisco Bay by 37 percent. More than 500,000 acres of the estuary's historic tidal wetlands have been converted to farms, salt ponds, and urban uses. Today, nearly 30 percent of the land in the nine counties surrounding San Francisco Bay is urbanized. The increase in urban land reflects the growth of the human population. There are now more than 7.5 million individuals living in the 12 Bay Area counties, making the region the fourth most populous metropolitan area in the United States. These changes have reduced the acreage of valuable farm land, wetlands, and riparian areas, and have increased pollutant loadings to the estuary. Installation of docks, shipping wharves, marinas, and miles of rock rip rap for shoreline protection has also contributed greatly to habitat degradation within the estuary.

Channel manipulations for flood control, bank stabilization, and gravel extraction have reduced the amount of valuable riffle habitat for rearing juvenile salmonids throughout the coastal stream portion of the action area.

d. Water Quality

Many waterways in the coastal action area fail to meet the Federal Clean Water Act and Federal Safe Drinking Water Act water quality standards due to the presence of pesticides, heavy metals, dioxins and other pollutants. These pollutants originate from both point- (industrial and municipal waste) and nonpoint (agriculture, forestry, urban activities, etc.) sources. The types and amounts of compounds found in runoff are often correlated with land use patterns: fertilizers and pesticides are found frequently in agricultural and urban settings, and nutrients are found in areas with human and animal waste. People contribute to chemical pollution in the area, but natural and seasonal factors also influence pollution levels in various ways. Nutrient and pesticide concentrations vary considerably from season to season, as well as among regions with different geographic and hydrological conditions. Natural features (such as geology and soils) and land-management practices (such as storm water drains, tile drainage and irrigation) can influence the movement of chemicals over both land and water. Salmon require clean water and gravel for successful spawning, egg incubation, and fry emergence. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs. Pollutants, excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect the water quality for salmon and steelhead. Return water from irrigated fields can introduce nutrients and pesticides into streams and rivers. Sediments washed from the urban areas contain trace metals such as copper, cadmium, zinc, and lead (California State Lands Commission 1993).

e. Altered Flow Patterns

Instream flows within the Coastal action area are strongly influenced by land-use practices, water diversion, and seasonal weather patterns. Loss of native perennial vegetation, soil compaction, and hillside trailing by livestock has produced an abbreviated hydrologic cycle within a significant portion of the streams within the Coastal action area. This altered cycle is characterized by higher peak flows during storm events; a rapid decline in flows during the spring; and a greater propensity for intermittent stream flow during low flow periods (R. Smith, United States Forest Service, personal communication, 2002).

In some of the larger river systems, regulated flows from mainstem dams has increased summer stream flow eliminating thermal stratification of pools, and have led to a shift in the fish community to warmwater fish species. Flow and temperature conditions now favor warmwater species in many of these mainstem systems and have compromised salmonid rearing and migration. Regulated flows also enable agricultural and urban development within these watersheds which has resulted in further impacts to salmonids in the form of increased runoff to streams, increased sedimentation, channelized tributaries, impacts to riparian vegetation, and decreases in stream flow (Spence *et al.* 1996).

Intermittent stream flows within the Coastal action area are a significant problem for rearing juvenile salmonids. Many smaller streams experience seasonal dewatering to a certain degree. When these seasonal intermittent flows occur, juvenile salmonids are trapped in isolated pools. Survival of these fish is relatively low and mortality has been reported in some studies to be as high as 47 percent for coho salmon and 82 percent for steelhead in some of these streams (R. Smith, United States Forest Service, personal communication, 2002). Mortality most often results from the effects of poor water quality, predation, reduced forage sources, and/or dessication of habitat. In one study (R. Smith, United States Forest Service, personal communication, 2002), it was estimated that this mortality alone accounted for approximately 33 percent of the total estimated juvenile coho salmon population in Olema Creek, California, during 1999.

Water is diverted from coastal streams for urban, commercial, agricultural, and residential use. In addition to a number of large reservoirs on coastal streams, there are an unknown number of permanent and temporary water withdrawal facilities that divert water for similar purposes. Impacts from water withdrawals include localized dewatering of stream reaches, entrapment of younger salmonids, and depletion of flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. Unprotected or poorly screened water diversions can also impact young salmonids; young fry are easily drawn into water pumps or become stuck against the pump's screened intakes. Unscreened or inadequately screened diversions are common throughout the action area.

Water withdrawals (primarily for irrigation) have reduced summer flows in nearly every stream in the action area and thereby profoundly decreased the amount and quality of salmonid rearing habitat. Water quantity problems are a significant cause of habitat degradation and reduced fish production. A significant proportion of the action area is irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion of it. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, urban consumption, and other uses increases temperatures, smolt travel time, and sedimentation.

/ *Gravel Mining*

Gravel mining is a major cause of sediment deficit in coastal California watersheds. In-channel mining removes gravel by either skimming it from bars or excavating it directly from the channel. Over-harvesting of gravel can lead to river incision, bank erosion, habitat simplification, and tributary downcutting (Steiner Environmental Consulting 1996).

Gravel mining has resulted in morphological changes to many coastal river systems. Decreased sediment load has caused these rivers to increase in depth, resulting in extensive bank erosion (Florsheim and Goodwin 1993). Degradation or downcutting of the channel due to past mining in the middle reaches of some rivers has also lead to impacts on adjacent ground water tables.

Loss of spawning gravels has a direct impact on salmonids within the action area. Female salmon choose spawning sites where there is clean, loosely compacted gravel or cobble substrates with less than 20 percent fine silt or sand content, and an intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Turbidity as a result of increased erosion and sedimentation caused by gravel mining can also be a limiting factor for anadromous salmonid populations. Salmonids are particularly sensitive to turbidity (Bjornn and Reiser 1991); it may lead to failed spawning, reduced respiratory efficiency, interruption of migration, altered prey base, reduced visibility, and reduction in plant production. Reduced plant production may, in turn, lead to lower dissolved oxygen levels and diminished food and cover for fish and aquatic insects.

g. Dams

Dams have a wide variety of functions including hydropower production, residential, commercial, and agricultural water supply; and flood and/or debris control. The development of dams in the rivers in the action area has dramatically affected anadromous salmonids utilizing these streams. Dams have eliminated spawning and rearing habitat and altered the natural hydrograph of most of the major river systems within the action area, decreasing spring and summer flows and increasing fall and winter flows. Channel narrowing can occur as the riparian zone becomes overgrown with vegetation that would otherwise have been scoured by frequent but moderate flows (Kondolf 1997). Dams cause flow levels and river elevations to fluctuate, slowing fish movement through reservoirs, altering riparian ecology, and stranding fish in shallow areas. The numerous dams within the action area alter salmonid migrations and may kill smolts and adults. Dams have also converted once-swift riverine environments into a series of slow-moving reservoirs, slowing the smolts' journey to the ocean and creating habitat for predators.

The construction of dams on rivers alters the transportation of sediment through the stream system. The inability to access tributary habitat areas limits anadromous salmonid populations throughout the coastal action area. Large mainstem dams on major rivers as well as smaller dams on tributaries degrade or block access to the most important salmonid spawning and rearing habitat. These dams not only interfere with the upstream migration of salmon and steelhead, but also reduce the highest flows that would occur without them, thus inhibiting the ability of the stream to flush out the system and move sediment through the stream channel.

Dams block the movement of sediments, limiting the recruitment of necessary spawning gravel downstream. Sediment above the dam is prevented from moving downstream, and sediment transport below the dam is changed. Channel characteristics, including the configuration and character of pools, riffles, and glides, are altered. Florsheim and Goodwin (1993) found that decreased downstream sediment transport caused a myriad of morphological problems, including increased river depth, which resulted in extensive bank erosion. In addition, tributary dams and domestic or agricultural water diversions reduce downstream flows and increase water temperatures (Prolysts, Inc. and Beak Consultants, Inc. 1984). Steiner Environmental Consulting (1996) reported that according to the United States Army Corps of Engineers (1982), the loss of tributary habitat was the primary factor limiting the recovery of the anadromous fishery in the Russian River basin.

Dams used for flood control have led to channel erosion, accompanied by an increase in particle size of the bed material. Since salmonids use freshwater gravels to incubate their eggs, the presence of the larger cobbles and boulders can threaten their spawning success (Kondolf 1997).

h. Commercial and Recreational Harvest

Historically, salmon and steelhead were abundant in coastal and interior streams of the coastal action area and have supported substantial tribal, sport, and commercial fisheries - contributing millions of dollars to numerous local economies. Over-fishing in the early days of the European settlement led to the depletion of many stocks of salmon and steelhead even before extensive habitat degradation. More recently, overfishing in nontribal fisheries is believed to have been a significant factor in the decline of salmon and steelhead. This included significant overfishing that occurred from the time marine survival turned poor for many stocks (ca. 1976) until the mid-1990s when harvest was substantially curtailed. Since 1994, the retention of coho salmon has been prohibited in marine fisheries south of Cape Falcon, Oregon. Coho salmon are still impacted, however, as a result of hook-and-release mortality in Chinook salmon-directed fisheries. Sport and commercial fishing restrictions ranging from severe curtailment to complete closures in recent years may be providing an increase in adult salmon and steelhead spawners in some streams, but trends cannot be established from the existing data.

Although currently no coho salmon may be legally retained in either marine or freshwater in California, CDFG port samplers routinely observe coho salmon retained from the ocean by recreational fisherman who either did not know the regulations or were not able to discern coho salmon from Chinook salmon. It is unlikely that steelhead were affected by ocean commercial or recreational fisheries, but freshwater recreational fishing for steelhead is a popular activity and may have intermittently reduced spawner abundance. However, coho salmon and steelhead populations have not rebounded since commercial and recreational fisheries have been curtailed to protect them.

/. Hatcheries

The use of state-funded fish hatcheries in California dates back to 1870. These facilities have been providing fish, predominantly salmon and trout, for sport and commercial fishing, for restoration, and for mitigation. There is concern that hatchery supplementation has resulted in major negative impacts to salmonids including loss of genetic diversity, displacement of native stocks, and disease transfer (Nehlson *et al.* 1991, Higgins *et al.* 1992, Cramer *et al.* 1995). The loss of genetic diversity through selective breeding, inbreeding and interbreeding concerns many fish biologists as this can compromise the ability of both wild and hatchery fish to adapt to environmental change (Weitkamp *et al.* 1995). Hatchery stocks are generally less fit for survival in streams than wild fish (Hillborn 1992). Hatchery stocks are often less successful at locating spawning gravels, avoiding predators, or finding natural food. Studies have found that subsequent generations of hatchery fish have a considerably lower survival rate than those of wild fish (Smith *et al.* 1985).

j. Ocean Conditions

An environmental condition often cited as a cause for the decline of west coast salmonids is the condition known as "El Niño" El Niño is a warming of the Pacific Ocean off South America and is caused by atmospheric changes in the tropical Pacific Ocean. During an El Nino event, a plume of warm sea water flows from west to east toward South America, eventually reaching the coast where it is reflected south and north along the continents. El Nirio ocean conditions are characterized by anomalously warm sea surface temperature and changes in thermal structure, coastal currents, and upwelling. Principal ecosystem alterations include decreases in primary and secondary productivity and changes in prey and predator species distributions. Several El Nirio events have been recorded during the last several decades, including those of 1940–41, 1957–58, 1982-83, 1986–87, 1991–92, 1993-94, and 1997-98. Johnson (1988) noted increased adult mortality and decreased average size for Oregon's Chinook and coho salmon during the strong 1982-83 El Nino. It is unclear to what extent ocean conditions have played a role in the decline of anadromous salmonids within the action area however, ocean conditions have likely affected populations throughout their evolutionary history.

k. Predation

Salmonids may be more vulnerable to predation by freshwater, avian, and marine predators with habitat modifications including the decrease in avoidance habitat such as deep pools, estuaries, and undercut banks. A decrease in water quantity and quality and adequate migration and rearing flows can also add to increased predation. While harbor seal and California sea lion numbers have increased along the Pacific Coast, their impact on salmonid populations appears to be minimal. For example, at the mouth of the Russian River, Hanson (1993) reported that the foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was negligible. Avian predators have been shown to impact some juvenile salmonids in fresh water and near shore environments. Ring-billed gulls *(Lams delawarensis)* consumed a small percent of the salmon and steelhead trout passing Wanapum Dam, in the Columbia River, during the spring smolt outmigration in 1982. Herons, cormorants, and alcids are known to prey on salmonids in the near shore marine environment. Piscivorous predators may have some influence on the abundance and survival of salmonids. Pearcy (1992) reviewed several studies of salmonids off the Pacific Northwest coastline and concluded that salmonid survival was influenced by the factional responses of the predators to salmonids and alternative prey.

The relative impacts of marine predation on anadromous salmonids are not well understood. Predators play an important role in the ecosystem, culling out unfit individuals, thereby strengthening the species as a whole. The increased impact of certain predators has been to a large degree the result of ecosystem modification. Predators may retard restoration or further exacerbate anthropogenic impacts. For example, diversion of stream flow for irrigation may affect the opening of sandbars at the mouths of creeks thereby altering the timing of adult spawning migrations and disposing fish to higher levels of marine mammal predation.

l. Natural Stochastic Events

Natural events, such as floods have depressed salmonid population numbers when these events occur. These species have persisted for thousands of years with these impacts. However, the more recent anthropogenic destruction and degradation of essential freshwater habitats have reduced the resiliency of salmonid populations to natural disturbances.

Floods can destroy or alter stream and lagoon habitats, accelerate erosion and sedimentation, and decimate eggs, fry and juvenile salmon populations, thus reducing or eliminating year classes (Anderson 1995). As previously mentioned, sedimentation of stream beds has been implicated as a principal cause of declining salmonid populations throughout their range. Floods can result in mass wasting of erodible hill slopes and failure of roads on unstable slopes causing catastrophic erosion. In addition, flooding can cause scour and redeposition of spawning gravels in typically inaccessible areas. During flood events, land disturbances resulting from logging, road construction, mining, urbanization, livestock grazing, agriculture, fire, and other uses may contribute sediment directly to streams or exacerbate sedimentation from natural erosive processes (California Advisory Committee on Salmon and Steelhead Trout 1988, California State Lands Commission 1993, Forest Ecosystem Management Assessment Team 1993).

m. Research Activities

Most biological opinions NOAA Fisheries issues recommend specific monitoring, evaluation, and research efforts intended to help gather information that would be used to increase the survival of affected listed fish. In addition, NOAA Fisheries has issued numerous research permits authorizing takes of ESA-listed fish over the last few years. Authorization for take by itself would not lead to decline of the species because NOAA Fisheries carefully evaluates each research permit and the combined effects of all previous permits and other activities on listed ESUs. However, the sum of the authorized takes indicate a potentially high level of research effort within the action area. In general, permit holders and applicants provide NOAA Fisheries with high take estimates to compensate for potential inseason changes in research protocols, accidental catastrophic events, and the annual variability in listed fish numbers. Also, most research projects depend on annual funding and the availability of other resources. So, a specific research project, for which take of ESA-listed species is authorized by a permit, may be suspended in a year when funding or resources are not available. As a result, the *actual* take in a given year for most research projects, as provided to NOAA Fisheries in post-season annual reports, is usually less than the authorized level of take in the permits and the related NOAA Fisheries consultation on the issuance of those permits.

Despite the fact that fish are harassed and even killed in the course of scientific research, only a small fraction of available habitat is sampled; therefore, only a small proportion of the total population is subject to sampling and the loss to the total population is small (McMichael *et al.* 1998). While threats to listed species vary among sites and populations, altered habitat and water regimes and exotic species are the primary factors affecting native fish fauna (Richter *et al.* 1997, Wilcove *et al.* 1998).

Research activities have a great potential to benefit ESA-listed salmon and steelhead. For example, permitted scientific research can provide data useful for the management and recovery of listed species. Aside from simply increasing what is known about the listed species and their biological requirements, research is essentially the only way to answer key questions associated with difficult resource issues that involve every salmonid life history stage. Further, there is no way to tell if the corrective measures described in the previous sections are working unless they are monitored and no way to design new and better corrective measures if research is not done. The information gained during research and monitoring activities will help resource managers recover listed species. The annual reauthorization of any section 10(a)(l)(A) permit is contingent upon receipt and approval of an annual report containing data on the preceding reporting period's research activities, a description of accomplished research activities, and a description of activities proposed for the forthcoming reporting period. In addition, all permit holders must submit a final report within ninety (90) days of the expiration of their permit summarizing the results of the research and the success of the research relative to its goals.

NOAA Fisheries does not consider scientific research and monitoring efforts (unlike the other factors described in the previous sections) to be a factor contributing to the decline of anadromous salmonids within the action area, and NOAA Fisheries believes that the information derived from the research activities is essential to their survival and recovery. Nonetheless, fish *are* harmed during research activities. And activities that are carried out in a careless or undirected fashion are not likely to benefit the species at all. Therefore, to minimize any harm arising from research activities on the species, NOAA Fisheries imposes conditions in its permits so that permit holders conduct their activities in such a way as to reduce adverse effects—particularly killing as few salmonids as possible. Also, researchers are encouraged to use nonlisted fish species and hatchery fish instead of listed naturally-produced fish when possible. In addition, researchers are required to share fish samples, as well as the results of the scientific research, with other researchers and comanagers in the region as a way to avoid duplicative research efforts and to acquire as much information as possible from the ESA-listed fish sampled. NOAA Fisheries also works with other agencies to coordinate research and thereby prevent duplication of effort..

n. Habitat Restoration

Restoration activities may cause temporary increases in turbidity and alter channel dynamics and stability (Habersack and Nachtnebel 1995, Hilderbrand *et al.* 1997, Powell 1997, Hilderbrand *et al.* 1998); these effects may temporarily stress salmonids. Misguided restoration efforts often fail to produce the intended benefits and can even result in further habitat degradation. Improperly constructed projects typically cause greater adverse effects than the pre-existing condition. The most common reason for this is improper identification of the design flow for the existing channel conditions. However, properly constructed stream restoration projects may increase available habitat, habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. The CDFG has produced a manual for stream restoration projects in California (see CDFG 1998a) providing guidance to maximize benefit to salmonids while minimizing risks. The negative effects of habitat restoration activities on anadromous salmonid populations in coastal streams within the action area are probably temporary and minor. Overall, habitat restoration projects are considered to be beneficial to the restoration and recovery of at risk populations.

Since 1996, the National Oceanic and Atmospheric Administration Restoration Center has provided $839,602, through cooperative agreements, for 41 restoration projects in coastal drainages. Types of projects funded include: fish migration barrier removal, fish migration barrier passage, riparian restoration and corridor fencing, salt marsh restoration, oyster reef habitat restoration, and road upgrade and decommissioning. Also, CDFG, other government entities, and private foundations have funded these and other types of restoration activities.

2. Central Valley Streams

The main risk factors that salmonids face in Central Valley streams include loss of a large portion of historic spawning habitats and degradation of remaining habitat, including migration corridors. CVSR Chinook salmon additionally face threats to their genetic integrity of the remaining wild spring-run Chinook populations from the Feather River Hatchery spring-run Chinook salmon program. CV steelhead also have a substantial opportunity for deleterious interactions with hatchery fish and have experienced a decline in the proportion of wild fish in spawning runs (NOAA Fisheries 2003).

California's robust agricultural economy and the state's rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuousity, volume, and reduces the lag time of water flowing through the system. An impressive network of water delivery systems have transformed the Central Valley drainage system into a series of lined conveyance channels and reservoirs that are operated by several pumping facilities. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds in the action area.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (e.g., Busby *et al.* 1996, Myers *et al.* 1998, U.S. Department of the Interior 1999, CALFED Bay-Delta Program 2000). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat (e.g., substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: commercial and recreational harvest, ocean conditions, predation, natural stochastic events, hydrographs, water quality and water quantity. Scientific research and habitat restoration activities may affect anadromous salmonid populations within the action area, but have not been specifically identified as factors contributing to the decline of these populations.

For the purposes of this document, a general description of the environmental baseline for CVSR Chinook salmon and CV steelhead is based on, in part, a summary provided in U.S. Department of the Interior (1999) and CALFED Bay-Delta Program (2000). In general, the human activities that have affected listed Central Valley anadromous salmonids and their habitats are: (1) dam construction that blocks previously accessible habitat; (2) water development activities that affect water quantity, water quality, and hydrographs; (3) land use activities such as agriculture, flood control, urban development, mining, and logging; (4) hatchery operation and practices; (5) harvest activities; (6) ecosystem restoration actions; (7) natural conditions; and (8) scientific research.

a. Habitat Blockage

Hydropower, flood control, and water supply dams of the Central Valley Project (CVP), State Water Project (SWP), and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and Delta block salmon and steelhead access to the upper portions of the respective watersheds. Clark (1929) estimated that originally there were 6,000 miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Clark (1929) did not give details about his calculation. Whether Clark's or Yoshiyama's calculation is used, only remnants of their former range remain accessible today in the Central Valley (CDFG 1998b).

b. Water Development Activities

Water development in the Central Valley has altered historical flow patterns in the Central Valley. Historical seasonal flow patterns included high flood flows in the winter and spring with declining flows throughout the summer and early fall. However, dams and diversion structures have dampened seasonal hydrographs and reduced the natural variability and quantity of streamflows throughout the year. The resulting changes to the seasonal hydrographs affect the timing of juvenile outmigration which are associated with flow surges. Furthermore, year round uniform flows result in diminished natural channel formations, altered foodweb processes, and regeneration of riparian vegetation. These changes to the stream channel have consequently altered and reduced salmonid habitat.

Water impoundment in upstream reservoirs reduces flows and dampens the magnitude and duration of peak flows during winter and spring. Reduced flows have contributed to higher temperatures, lower dissolved oxygen levels, and decreased recruitment of gravel and large woody debris. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Hundreds of small and medium size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened intakes entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions mapped in a Geographical Information System in the Central Valley were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

c. Land Use Activities

Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation spreading four to five miles (California Resources Agency 1989). By 1979, riparian habitat along the Sacramento River diminished to 11,000-12,000 acres or about 2 percent of historic levels (McGill 1979). More recently, about 16,000 acres of remaining riparian vegetation has been reported (McGill 1987). The degradation and fragmentation of riparian habitat has resulted mainly from flood control and bank protection projects, together with the conversion of riparian land to agriculture (Jones and Stokes Associates, Incorporated 1993).

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is a primary cause of salmonid habitat degradation. Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging, or abrading gill surfaces; adhering to eggs; inducing behavioral modifications; burying eggs or alevins; scouring and filling pools and riffles; reducing primary productivity and photosynthetic activity; and affecting intergravel permeability and dissolved oxygen levels. Embedded substrates can reduce the production of juvenile salmonids and hinder the ability of some over-wintering juveniles to hide in gravel during high flow events.

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through alteration of streambank and channel morphology; alteration of ambient stream water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of gravel and large woody debris; and removal of riparian vegetation resulting in increased streambank erosion. Agricultural practices have eliminated large trees and logs and other woody debris that would have been otherwise recruited to the stream channel. Large woody debris influences stream morphology by affecting pool formation, channel pattern and position, and channel geometry.

Historically in the Delta, tidal marshes provided a highly productive estuarine environment for juvenile anadromous salmonids. During the course of their downstream migration, juvenile winter-run Chinook salmon, spring-run Chinook salmon, and steelhead use the Delta's estuarine habitat for seasonal rearing, and as a migration corridor to the sea. Since the 1850's, reclamation of Delta islands for agricultural purposes caused the cumulative loss of 94 percent of the Delta's tidal marshes (Association for Bay Area Governments 1992).

In addition to the degradation and loss of estuarine habitat, downstream migrant juvenile salmon in the Delta have been subject to adverse conditions created by water export operations of the CVP and SWP. Specifically, juvenile salmon have been adversely affected by: (1) water diversion from the mainstem Sacramento River into the Central Delta via the manmade Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; and (3) entrainment and mortality at the CVP/SWP export facilities and associated problems at Clifton Court Forebay. Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges.

d. Hatchery Operation and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley are primarily caused by the straying of hatchery fish and the subsequent hybridization of hatchery and wild fish. In the Central Valley, practices such as trucking smolts to distant sites for release and the transferring of eggs between hatcheries contribute to elevated straying levels (U.S. Department of the Interior 1999).

e. Harvest

The ocean salmon fisheries in the exclusive economic zone off Washington, Oregon, and California are managed by NOAA Fisheries under authority of the Magnuson-Stevens Fishery Conservation and Management Act. Management measures are developed according to the Pacific Coast Salmon Plan (FMP) and implemented by NOAA Fisheries if they are found to be consistent with the Magnuson-Stevens Act and other applicable law, including the ESA. The Secretary of Commerce, acting through NOAA Fisheries, has the ultimate authority for the FMP and its implementation; NOAA Fisheries is therefore both the action agency and the consulting agency in the section 7 consultation required under the ESA, and NOAA Fisheries issues the associated incidental take permit to itself.

Ocean salmon fisheries off California are managed to meet the conservation objectives for certain stocks of salmon listed in the FMP, including any stock that is listed as threatened or endangered under the ESA. FMP objectives exist for some ESA listed stocks, but for others, including Central Valley spring-run Chinook salmon, the FMP objective is the Reasonable and Prudent Alternative of NOAA Fisheries' biological opinion on implementation of the FMP. Through a series of section 7 consultations on ocean fisheries managed under the FMP (NOAA Fisheries 1996, 1997b, 2000, 2002a), NOAA Fisheries has taken measures to reduce the impacts of commercial and recreational fisheries on Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon to levels that are consistent with recovery of the populations.

To address potential incidental take of Chinook salmon that occurs in the recreational trout fishery, the California Fish and Game Commission adopted in 1992 gear restrictions (all hooks must be barbless and a maximum 5.7 cm in length) to minimize hooking injury and mortality caused by trout anglers incidentally catching winter-run Chinook salmon. Specific regulations for the protection of spring-run Chinook salmon in Mill, Deer, Big Chico, and Butte Creeks were added to the existing CDFG regulations in 1994. Existing regulations, including those developed for winter-run Chinook salmon provide some level of protection for spring-run fish (CDFG 1998b).

There is no commercial harvest of Central Valley steelhead. All wild steelhead caught in California must be released unharmed except in the Smith River (CDFG 2003a). Limited information exists on steelhead recreational harvest rates in California.

/ *Ecosystem Restoration*

Significant steps towards the largest ecological restoration project yet undertaken in the United States have occurred during the past several years and continue to proceed in California's Central Valley. The CALFED Bay-Delta Program, in coordination with other Central Valley efforts including those implemented through the Central Valley Project Improvement Act, has implemented numerous habitat restoration actions that benefit Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and critical habitat for Sacramento River winter-run Chinook salmon. These restoration actions include the installation of fish screens, modification of barriers to improve fish passage, and habitat acquisition and restoration. The majority of these recent restoration actions address key factors for decline of these ESUs and emphasis has been placed in tributary drainages with high potential for spring-run Chinook salmon, and steelhead production. Additional actions that are currently underway that benefit Central Valley spring-run Chinook salmon, and Central Valley steelhead include new efforts to enhance fisheries monitoring and conservation actions to address artificial propagation.

A beneficial action unrelated to the CALFED Program includes the Environmental Protection Agency's remedial actions at Iron Mountain Mine. The completion of a state-of-the-art lime neutralization plant is successfully removing significant concentrations of toxic metals in acidic mine drainage from the Spring Creek Watershed. Containment loading into the upper Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990's.

g. Natural Conditions

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as El Nino, appear to change ocean productivity. During the first part of the 1990's, much of the Pacific Coast was subject to a series of very dry years.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of coded-wire tag (CWT) recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although it is not known to what degree. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has caused a number of salmonid deaths.

Finally, it should be noted that the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento watershed and San Joaquin watershed was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that passed downriver during the 2001 spring and summer out-migration likely were affected and this, in turn, may affect adult returns primarily in 2003 and 2004, depending on the stock and species. At this time, it is impossible to ascertain what those effects will be, but NOAA Fisheries is monitoring the situation and will take the drought condition into account in management decisions, including amending take authorizations and other permit conditions as needed.

h. Scientific Research

Please see discussion on research activities described in the coastal section above.

V. EFFECTS OF THE PROPOSED ACTION

The purpose of this section is to identify effects on ESA-listed salmonids resulting from NOAA Fisheries proposal to limit ESA take prohibitions (under the authority of section 4(d) of the ESA) for juvenile and adult salmonids taken in CDFG's research program. Detailed descriptions of the 78 projects including the sampling location, time, and frequency, and amount and type of take activity estimated to result from a project are provided in Table 3.

Several sampling techniques will be used by the 78 projects in CDFG's Program. Common techniques used in fisheries research and the potential effects they have on ESA-listed salmonids are described below. The effects of projects with the greatest potential for impacting the likelihood of survival and recovery of a population, and a summary of the effects of the Program as a whole is then provided.

A. Effects Associated with Direct Observation

Provided that visibility and other conditions are sufficient, direct observation is used to gather important data on habitat utilization, behavior, distribution, and for estimating population size and structure. Direct observation can entail walking the side of the water body, or underwater observation techniques such as snorkeling, scuba diving, and video photography. Observing fish by walking the side of the water body is done only on small bodies of water or the littoral zones of large bodies of water. Underwater observation is most frequently used in small lakes, streams, and tidepools, however, can be undertaken efficiently in large, deep water bodies (e.g., oceans, rivers, and reservoirs) provided that conditions are adequate (Dolloff *et al.* 1996). Turbidity, turbulence, target species behavior, habitat structure and complexity, hydrology, ambient light, and, perhaps, weather affect the efficiency of direct observation.

Another type of direct observation involves spawning surveys. In these surveys the observer walks directly in the stream during spawning season, as close to the edge as possible, locating redds and carcasses. These surveys usually involve the concurrent observation and notation of spawning salmonids as well. Salmonid carcasses are measured, the sex is determined, and scale and tissue samples are usually collected. Redds are usually flagged and the locations recorded. One of the effects of this type of survey is the possible disturbance of redds if the observer accidentally steps on one. If spawning salmonids are present during these surveys then the fish can be unintentionally frightened off by the observer, disrupting their spawning activities or their effort to guard the redd after spawning.

Direct observation is the least intrusive method for determining presence/absence of the species and estimating their relative abundance. Effects of direct observation are generally the shortest-lived among any of the research activities discussed in this section. Videography should induce no effects on ESA-listed fish. Using other forms of direct observations, a cautious observer can effectively obtain data without disrupting the normal behavior of a fish.

There is no evidence that fish are injured by direct observations. Observations made by State and Federal fishery biologists counting Chinook salmon and steelhead in Central Valley streams indicate that direct observation does not cause any behavioral effects that prevent salmon and steelhead from successfully holding, spawning, or feeding (Paul Ward, CDFG, personal communication 2002, Sarah Giovannetti, U.S. Fish and Wildlife Service, personal communication 2003). Snorkeling surveys may frighten adult and juvenile spring-run Chinook salmon and steelhead, which may cause the fish to seek temporary refuge behind rocks, vegetation, and deep water areas. Frightened juveniles return to feeding habitats, and adults return to holding and spawning habitats within seconds after the observer passes through the habitat unit. In some cases, salmon may temporarily leave the particular pool or habitat type when observers are in their area. Adult mortalities do not occur because snorkel encounters with Chinook salmon are brief and do not involve any physical contact. Researchers minimize the amount of disturbance by limiting the number of times that each habitat unit is snorkeled and by moving through areas deliberately and without unnecessary, abrupt, or erratic body movements.

B. Effects Associated with General Capture and Handling

Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process and, therefore, the overall effects of the handling are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the original habitat and the container in which the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma (Kelsch and Shields 1996). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18 °C or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process. In addition, when fish are handled by samplers to obtain measurements and other data, it is not uncommon for fish to be dropped on the ground by the handlers because the fish are not sedated enough or properly restrained. This can result in internal injuries, especially in females with developing ovaries (Stickney 1983). An injured fish is more susceptible to developing diseases, which can lead to delayed mortality. Some of the injuries which can lead to disease are the loss of mucus, loss of scales, damage to integument and internal damage (Stickney 1983, Kelsch and Shields 1996). In addition to the risks associated with handling, all fish handled will be exposed to additional risks specific to the various methods of capture described in the following subsection.

C. Collection Gear Specific Effects

Following are brief descriptions of effects of different capture methods and their associated collection gears. More detailed descriptions can be found in Nielsen and Johnson (1983) and Murphy and Willis (1996). Limited information exists on the injury and mortality rates to fish resulting from the capture methods described below.

1. Tagging and Marking

The use of passive integrated transponder (PIT) tags, coded wire tags (CWT), fin-clips, and biotelemetry transmitters are common to many scientific research efforts using ESA-listed species. Some tags or marks allow biologists to identify groups of fish (e.g., hatchery-produced fish or test fish) and some allow for the identification of individual fish. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish.

a. PIT Tags

A PIT tag is an electronic device that relays signals to a receiver; it allows individual fish to be identified whenever they pass a location containing such a receiver (e.g., some fish ladders) without researchers having to handle the fish. The tag is inserted into the body cavity of the fish using a modified hypodermic needle, typically, just in front of the pelvic girdle. The insertion of PIT tags requires that the fish be captured and extensively handled, therefore the fish can be affected by any or all of the associated risks mentioned in the section on capture and handling methods. PIT tags have very little effect on growth, survival, swimming speed, stamina, or behavior (Jenkins and Smith 1990, Prentice *et al.* 1990, Prentice *et al.* 1994). Mortalities associated with PIT tags have been found to be less than 1 percent (Dare 2003).

b. Coded Wire Tags

Coded wire tags are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, and hatchery of origin (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific salmon. In salmon, CWTs are injected into the nasal cartilage and, therefore, cause little direct tissue damage (Bergman *et al.* 1968). A major advantage to using CWTs is that external and internal tissue damage from the tag and injections heals rapidly and is minor (Bergman *et al.* 1968, Fletcher *et al.* 1987, Buckley and Blankenship 1990). In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem for the salmonid population because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest, or post-spawning carcass surveys.

c. Biotelemetry Tags

Biotelemetry tags (or radio tags) are implanted transmitters which allow one to identify and follow an individual fish continuously and remotely and to gather information on migration and habitat utilization. There are two main ways to implant a tag and they differ in both their characteristics and consequences. The first method of implanting a tag is to slip it into the fish's stomach through the esophagus. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. A second common method for implanting a tag is to surgically implant the tag within the body cavity. These tags generally do not interfere with feeding or movement, though the size of the tag and fish do influence effects. However, the surgical procedure is difficult, requiring considerable experience and equipment (Summerfelt and Smith 1990, Nielsen 1992). Because the tag is placed within the body cavity, the tag may injure a fish's internal organs. An improperly positioned incision may cause serious injury to the fish. Also, infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985, Mellas and Haynes 1985, Summerfelt and Smith 1990). Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. Radio tag mortalities for gastric and surgically implanted tags is 2-3 percent (Adams *et al.* 1998). Only one project in the Program proposes to use radio tags as part of its activities. Based on expected captures in this project, NOAA Fisheries anticipates that one adult NC steelhead may die during project implementation.

d. Fin Clipping

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins.

Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat variable; however, it appears that fin clips do not generally alter fish growth. Moreover, wounds caused by fin clipping usually heal quickly, especially those caused by partial clips. Mortality among fin-clipped fish is also variable (Duke 1986). Some immediate mortality may occur during the process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Mortality depends on species and ambient conditions. Also, small fishes are more sensitive to handling; Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Mortality is generally higher when the major median and pectoral fins are clipped. By convention, an adipose mark has significance in California and implies that a fish has been implanted with a coded-wire tag. The main risk to fish, therefore, would likely result from initial capture and handling to clip the fin.

2. Hoop Nets

Hoop nets are cylindrical or conical nets that are distended by a series of hoops or frames covered by web netting. A hoop net has one or more internal funnel shaped throats that are directed inward from the mouth of the net. The throats direct and trap the fish in the back end (codend) of the net. The net is held in place by ropes, weights, or stakes. Hoop nets are typically used in lakes and reservoirs, but are sometime used in river habitats. To increase capture efficiency of highly migratory fish, some hoop nets are set with "wings" of netting attached to the mouth of the net. The wings intercept migrating fish and direct them into the mouth of the net. Typically, fish are removed from hoop nets by scooping the fish out of the internal compartments using a dip net. Hoop nets are most effective for species that are attracted to cover, or other fish, or that are intercepted by the wings. Net construction (size and materials) and placement influence efficiency of hoop nets. Fish captured with hoop nets are generally captured unharmed, though there are some risks associated with hoop nets: small fish can be "gilled" in the netting, captured fish are subject to crowding and in-net predation from other fish, or injury by removal of the fish by dip net.

3. Seines

A seine is a net that traps fish by encircling them with a long wall of webbing. Typically, the top edge of a seine has floats, the bottom edge is weighted, and the seine has a brail (wooden pole) on each end. As the net is closed the fish become concentrated in the net. Seines are usually large enough that they are fished by two or more people, though can be small enough to be fished by one person. Generally, seines are set in an arc around the targeted fish and then dragged to shore. Seines are effective for sampling littoral areas of lentic habitats. In lotic habitats, seines are most easily used in areas of low velocity, but can be used in high velocity areas if the brails are held in place while someone approaches the net from upstream, herding fish into the net. To be most effective, a seine needs to be deployed quickly enough that the target species cannot escape the encircling net. Accordingly, habitat structure and complexity negatively influence seine efficiency by reducing the speed at which one deploys a seine and by offering escape cover. Small fish can be gilled in the mesh of a seine. Scales and dermal mucus can be abraded by contacting the net. Fish can be suffocated if they are not quickly removed from the net after the net is removed from the water to process the fish. Also, the fish can be crushed by the handler when removing the net from the water.

4. Trawls

Trawls are cone-shaped, mesh nets that are towed, typically, along benthic habitat (Hayes 1983, Hayes *et al.* 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the codend of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Stickney 1983, Hayes *et al.* 1996).

5. Hook and Line

The use of hook and line (angling) is typically associated with recreational or commercial fishing, but can be used for collecting research samples (Hayes *et al.* 1996). Angling can target specific species or size of fish. Angling has been used in scientific studies for a variety of research activities including conducting radiotelemetry studies, studies of fish genetics, fish mortality and fish population structure and abundance. Another form of hook and line capture is a trotline. A trotline has a main line strung horizontally with short vertical lines (drop lines) attached to it (Hubert 1996). Each of the vertical lines has a baited hook attached to it. Trotlines are used frequently in warmwater inland fisheries and are generally used to capture catfish or common carp. Hook and line captures exercise size selectivity and extreme variability in catch rates. Injuries related to hook and line capture are influenced by hook size and type, bait or lure choice, and species behavior. Common hook and line injuries include damage to the skeletal structure of the mouth, injury to gills, and secondary infections. Fish may be additionally stressed from handling, especially if the fish is kept out of the water before it is released. Mortality resulting from hook and line capture and release averaged 7.5 percent with wound location and bleeding as primary factors associated with mortality; most mortalities occurred within 72 hours of release (Bendock and Alexandersdottir 1993).

6. Electrofisher

Electrofishing is a process by which an electrical current is passed through water in order to stun fish and facilitate capture. It can also be used to guide or block their movements. There are three general systems for electrofishing related to where the electrical generator is maintained: backpack, boat, and shore. Backpack electrofishing is the most common system used for salmonids. Boat and shore electrofishing units often use more current than backpack electrofishing equipment because they are used to cover larger (and deeper) areas and, as a result, potentially have a greater impact on fish. This biological opinion considers only backpack electrofishing.

Two or three technicians work together while backpack electrofishing. One person carries the backpack and searches the target habitats with the anode, while one or two others net stunned fish. Operators work in teams to increase the number of fish that may be seen or captured. Working in teams also allows the researcher to net fish before they are subjected to higher electrical fields.

The use of electricity to capture fish is one of the most intrusive and risky methods. This method of capture can result in a variety of effects from simple harassment to injury to the fish (adults and juveniles) and death. There are two major forms of injuries from electrofishing; hemorrhages in soft tissues and fractures in hard tissues. Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey *et al.* 1996, Ainslie *et al.* 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. Dalbey *et al.* (1996), reports that the growth of rainbow trout was markedly lower when there was moderate to severe electrofisher induced spinal injury. Electrofishing can also result in trauma to fish from stress. The stress caused by electrofishing is usually not recognized because the fish often appear normal upon release. Recovery from this stress can take up to several days, and during this time the fish are more vulnerable to predation, and less able to compete for resources. Stress related deaths can also occur within minutes or hours of release, with respiratory failure usually the cause.

The waveform produced by the electrofisher affects injury potential. Continuous direct current or low-frequency (≤30 Hz) pulsed direct current have been recommended for electrofishing (Fredenberg 1992, Snyder 1992, Snyder 1995, Dalbey *et al.* 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber *et al.* 1994, Dalbey *et al.* 1996).

The age or stage of development of the target species affects injury rates too. Electrofishing can have severe effects on adult salmonids, particularly spinal injuries from forced muscle contraction. Sharber and Carothers (1988) reported .that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey *et al.* 1996, Thompson *et al.* 1997). McMichael *et al.* (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River subbasin. Cho *et al.* (2002) showed that electrofishing has dramatic negative effect on survival of eggs from electroshocked females (up to 93 percent mortality) and eggs electrofished post spawning (up to 34 percent mortality).

7. Dip Nets

Dip nets are bag shaped nets on a frame attached to a handle. The net is placed under the fish and then lifted from the water in a scooping motion. Dip nets are useful when collecting fish that have been trapped by other methods, such as electrofishing or trap nets. Scales and mucus can be abraded by the net, and fish can be crushed by the frame when the handler is attempting to catch them.

8. Traps

There are several common types of traps used to catch fish (e.g., fyke traps, screw traps, and pot gears). Fyke nets also are known as wing nets, frame nets, trap nets, and hoop nets (Hubert 1996). These nets generally are used in shallow waters of lakes and reservoirs, but they can also be used in deep water and in streams with slow currents. Modified fyke nets have frames across them near the mouth for stabilization. Fyke nets have leads or wings of webbing attached to the mouth to guide fish into the enclosure. Fish will swim into the enclosure as they follow the lead or wing in an attempt to get around the netting. Fish captured with fyke and trap nets are less stressed than fish captured with entanglement gears and are usually released unharmed. However, the use of these nets can cause abrasion to fish from shaking fish down into the cod end prior to removal. Furthermore, these nets can result in mortality when small fish are gilled in the mesh of the nets.

Screw traps are used in rivers of medium flow to capture fish as they travel downstream. They are large cones attached to a catamaran. Screw traps are manufactured in various diameters (approximately 3-5 feet), and are placed horizontally in the stream bed with the open end of the cone facing upstream. Half of the open end of the cone is above the water. The fish enter the open end and proceed through a corkscrew in the downstream end of the trap. At the end of the corkscrew is a box for live capture, which will hold the fish. The purpose of the corkscrew is to prevent the fish from escaping out the open funnel end of the trap.

Pot gears are traps that are portable and rigid, with small openings for animals to enter and are usually small enough to be carried by hand (Hubert 1996). They are typically weighted with stones and marked by a buoy. Some examples of typical pot gears are lobster pots, minnow traps, slat traps for catfish, eel pots and crab pots. These traps are used to capture fish and crustaceans and are most efficient at capturing bottom-dwelling species seeking food or shelter. Fish are captured in the trap when they pass through a conical shaped funnel to reach a receptacle containing bait. One of the risks associated with the use of pot gears is that the gear can continue to capture animals if it is lost, a process called ghost fishing. Fish caught in the various types of pot traps can be crushed by in-trap weight.

Fish caught in traps experience stress and injury from overcrowding if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. Fish caught in traps are vulnerable to in-trap predation by other fish and to predation by mammals, birds, or reptiles that are able to enter the trap.

9. Gill Nets

Gill nets are walls of netting suspended vertically in the water by a float line on the top and lead line on the bottom. The mesh of gill nets is relatively large; fish attempt to pass through the mesh and are captured. Fish are caught in the net in one of three ways: (1) gilled - held by mesh slipping behind the opercula, (2) wedged - held by the mesh around the body, or (3) tangled - held by teeth, spines, maxillaries or other protrusions without penetration of the mesh (Nielsen and Johnson 1983). Fish are primarily caught in the net by being gilled. When a fish is gilled the opercula do not open and close efficiently and disrupt respiratory gas exchange, leading to suffocation. Sometimes fish are injured while being removed from a gill net, including damage to internal organs from being squeezed, damage to scales and mucus, and damage to jaws and other protruding segments of the body. Soak time proportionally affects the lethal nature of gill nets (Hubert 1983, Hubert 1996); therefore, use of short-length gill nets that are checked frequently should reduce injury. Since gill nets are highly lethal and stress fish more than other forms of passive gears (Hubert 1996), gill nets should not be the preferred gear for capturing live fish for release. Mortality associated with gill nets can be reduced to as little as 6 percent with the of short net soak times, careful handling of fish on removal from the net, and a recovery box (Fraser *et al.* 2002).

10. Gastric Lavage

Information on fish diet may be useful in endangered species management. A significant component of diet studies is to know the content of a fish's stomach; the simplest and most primitive method is to kill the fish, surgically remove its stomach, and describe the stomach contents. However, sacrificing ESA-listed fish for diet analyses is not acceptable. Fortunately, there are several nonlethal methods available for determining the diet of listed fish. Most times gastric evacuation entails inserting a tube through the esophagus to the stomach of a fish and then flushing the stomach contents. Alternative methods include the use of emetics, vacuuming the stomach, the use of forceps, or flushing the anus. Kamler and Pope (2001) reviewed several gastric evacuation methods and found that most procedures were relatively safe and effective at removing stomach contents. Some risks associated with gastric lavage include: increased handling time and associated stress; injury to the soft tissues of the esophagus, stomach, or intestine; and, with some techniques, injury to the jaws and anesthetic-related injury. Most reported levels of injury are quite low, frequently zero (reviewed in Kamler and Pope 2001), but Sprague *et al.* (1993) reported 33 percent mortality in juvenile white sturgeon (Acipenser transmontanus) and Hartleb and Moring (1995) reported mortality of 60 percent in golden shiner (Notemigonus crysoleucas). Haley (1998), however, showed that mortality in juvenile sturgeon could be greatly reduced by using smaller, more ductile tubing than used by Sprague *et al.* (1993), and by anesthetizing test fish. Gastric lavage has been used safely, and effectively in salmonids (Meehan and Miller 1978, Meehan 1996, Kamler and Pope 2001). Meehan and Miller

(1978) reported 10-15 percent mortality (after 30 days) in coho salmon that were collected by electrofisher, subjected to gastric lavage, transferred to a laboratory, and held 30 days; it is not possible to determine which factor had the greatest influence on survival. We expect less mortality because the applicant has not proposed transfer of specimens from the collection site, or holding of specimens after treatment.

D. Program Effects

The cumulative total take of adult and juvenile fish from each ESU estimated to result from the Program's 78 projects is summarized in Table 2. The majority of take resulting from the Program will be non-lethal in nature, and effects on the survival of individual fish exposed to such take is likely to be discountable. For most ESUs, less than 2 percent of the total take will result in mortality to fish (with the exception of 3.8 percent lethal take of adult NC steelhead and 5.3 percent of juvenile Central Valley steelhead), and in no case will lethal take exceed 5.3 percent of fish sampled for an ESU. The estimated amount of take for each project has been confirmed for accuracy and reasonableness by the principal investigator and NOAA Fisheries biologists.

The primary effects of the Program on ESA-listed salmonids are expected to be stress and other sub-lethal effects caused by observing, capturing, and handling fish. Non-lethal take from non-invasive methods mentioned above should not, in general, impact the chance of survival of individual fish. Unintentional harassment, harm, and mortality may occur during handling or after the fish has been released. Based on prior experience with the research techniques and protocols that will be used to conduct the proposed scientific research, no more than five percent of the juvenile salmonids encountered are likely to be killed as an indirect result of being captured and handled and, in most cases, this lethal take will not exceed three percent (NOAA Fisheries, unpublished data). NOAA Fisheries expects that less than one percent of the adults handled will die (NOAA Fisheries, unpublished data).

Furthermore, the Program will affect more juvenile fish than adult fish, which in turn will result in less impact on a population or ESU. At least 97 percent of the estimated total take for any given ESU is for take of juvenile fish, with the exception of CV steelhead (86 percent; Table 2). Take of juvenile fish would impact a population or ESU less than take of adult fish because of the expected survival rates of juvenile and adult fish. Adult fish that return to freshwater to migrate to their spawning grounds have overcome numerous obstacles during their freshwater and ocean residence (e.g., predation, competition, water diversions, etc.). For example, 23 years of monitoring adult survival of hatchery-released fall-run Chinook salmon showed an average of 0.35 percent of fish return as adults to spawn in freshwater in the Central Valley during 1973-1995 (USFWS 2001). Juvenile salmon in the Central Valley survival rates from fry to smolt stage range from 3 percent to 34 percent in the Sacramento River system (Healy 1991). In estimating the juvenile production of endangered Sacramento River winter-run Chinook salmon, NOAA Fisheries (2002b) approximates 15 percent of salmon survive to smolt age passing through the Sacramento-San Joaquin Delta on their seaward migration.

The majority of any impacts to the recovery of any given ESU from the Program is attributable to fewer than a dozen projects (Table 3). We discuss the effects of 10 specific projects that account for the greatest impact on the survival and recovery of each ESU (i.e., highest proportion of take, resiliency of population in a watershed) from the Program, and then summarize the effects of the remaining 68 projects that together account for a nominal impact to an ESU. In particular, we analyze the potential effects of the select projects and consider the type of take activity, sampling gear, sampling frequency, stream location, time of year of sampling, and the life stage of listed fish that may be affected by the project.

1. Coastal ESU's

Table 2a.
Estimated take of adult and juvenile fish for the coastal Evolutionarily Significant Units

Evolutionarily Significant Unit	Adult Non-lethal	Adult Lethal	Adult % Lethal take	Juvenile Non-lethal	Juvenile Lethal	Juvenile % Lethal take	Total take	% Adult take	% Juvenile take
So.Oregon/No. California Coasts coho salmon	800	15	1.8	203,118	688	0.3	204,621	0.4	9976
Central California Coast coho salmon	0	0	0.0	24,550	234	0.9	24,784	0.0	100.0
California Coastal Chinook salmon	500	10	2.0	191,590	1,690	0.9	193,790	0.3	99.7
Northern California steelhead	280	10	3.4	346,304	4,968	1.4	351,562	0.1	99.9
Central California Coast steelhead	75	0	0.0	37,404	765	2.0	38,244	0.2	99:8
South Central California Coast steelhead	0	0	0.0	8,275	60	0.7	8,335	0.0	100.0

Projects in the northern California watershed (the Mattole River north to the Oregon border) represent the southern range of the SONCC coho salmon and the northern range of the CC Chinook and NC steelhead. Populations in these watersheds are critical to the overall genetic diversity and population stability of these ESUs. In analyzing the effects to listed salmonids from the lethal take associated with CDFG research activities, NOAA Fisheries considered the amount of lethal take requested and the ability of the population in the target watershed to withstand this level of pressure. Projects representing the highest number of fish are not necessarily those that may have the greatest impact on the survival and recovery of an ESU. Larger populations may withstand higher lethal take levels without negative impacts; a smaller population could decline due to the loss of a few fish, especially adults. Furthermore, the smaller population may represent a valuable contribution to the genetic variability of the ESU, particularly if the population is isolated from other populations.

In most instances, requested lethal take represented a negligible impact on the salmon population in the watersheds where take will occur because the requested take numbers are small, relative to the watershed populations where the sampling will occur, and the requested take will be spread out over a large number of creeks. Applicants typically anticipate lethal take of 1 or 2 fish for every 100, or more, that they expect to handle. Furthermore, the lethal take for these projects will be only juvenile stage fish, mostly young of the year (YOY) and this life stage typically experiences naturally high mortality rates often as high as 99% during the first year. For example, in Freshwater Creek, the number of coho salmon declined from an estimated 200,000 YOY in April 2001, to 66,000 in August 2001, to 3000 out migrant smolts in 2002, a mortality of 98.5 percent (Seth Ricker, CDFG, pers. comm. Nov. 2003). Survival from smolt to adult is much higher, typically 5 to 10 percent, and therefore lethal take from the smolt stage is more likely to translate in to fewer returning adults. Under desirable ocean conditions, return rates may increase significantly. For example, in Freshwater Creek, an estimated 1500 adults coho salmon (based on mark and recapture data) returned in 2002 from an estimated 6000 out migrants 2 years earlier (Seth Ricker, CDFG, pers. comm. Nov. 2003).

Typical of most applicants in the northern California coastal watersheds is one from Larry Preston, CDFG, (Project #22) who proposes to do general stream surveys by snorkel counts, minnow traps and electrofishing. Mr. Preston is requesting lethal take for 15 CC Chinook (nonlethal 500) and 100 NC steelhead (5,000 nonlethal), all juveniles, for 396 creeks north of San Francisco Bay. Another example is a request from Scott Harris, CDFG, (Project #5) to monitor and survey streams with down migrant trapping and electrofishing in the Eel, Russian rivers and other Mendocino coastal basins. Mr. Harris is requesting lethal take of 4 juvenile NC steelhead out of 5,000 he expects to handle non-lethally. These take requests, lethal and non, will be spread out relatively evenly over the entire proposed sampling area, rather than all the lethal take in one sample reach. Collectively, there are 13 permit applications in this general category that represent requests for lethal take of 12 SONCC coho salmon juveniles (1,100 nonlethal), 111 CC Chinook salmon juveniles (24,295 nonlethal), and 513 NC steelhead juveniles (43,905 nonlethal).

Six applicants made requests for high numbers of lethal take (200 to 1,000 fish) because they operate downstream migrant traps that tend to capture large numbers of fish. For example, Phillip Barrington, CDFG, (Project #13) is requesting lethal take of 1,093 CC Chinook and 538 NC steelhead in Upper Redwood Creek for operating a rotary screw trap on Upper Redwood Creek. Similarly, Harry Vaughn, Eel River Salmon Restoration Project, (Project #44) is requesting lethal take of 200 CC Chinook and 460 NC steelhead to operate in channel McBane modified pipe traps in Sproul Creek, a tributary to the South Fork of the Eel River. However, these take requests represent 0.5 -1.0 percent of their perspective nonlethal requested take for CC Chinook (120,713 for Mr. Barrington and 10,000 for Mr. Vaughn) and NC steelhead (118,543 for Mr. Barrington and 23,000 for Mr. Vaughn). Furthermore, as with the small scale projects, lethal take will be juvenile fish and mostly YOY.

Complicating matters for the applicants when requesting take is the huge variability in fish numbers that may occur in any sample area between years. Researchers must make a take request, from which lethal take is typically calculated, to account for the number of fish they could encounter, not necessarily what they expect to encounter. For example, Mr. Barrington has also requested lethal take of 650 SONCC coho salmon for a trapping study in the Freshwater Creek watershed (Project #78). However, this is based on a nonlethal take request of 201,104 juveniles, the actual number of fish captured by a CDFG study in 2001 (of which approximately 199,900 were YOY - the remaining fish were either yearlings or smolts). Although the usual number of juvenile coho salmon trapped in Freshwater Creek is substantially lower, ranging from 3,000 to 8,000 in the last few years, Mr. Barrington must consider the possibility of capturing this large number of fish again, and therefore request this high take number. Furthermore, with improved ocean conditions contributing to increased survival of salmon in general, applicants must presume increased fish numbers will continue in the foreseeable future. Because Mr. Barrington has requested a high lethal take based on a high population present, a lower number of sampled fish will translate into less lethal take. Therefore, NOAA Fisheries expects the lethal take for Mr. Barrington's study will be proportionate to the number of fish trapped. For example, his request for a lethal take of 650 fish is 0.3 percent of 200,000 and therefore sampling a more typical number of 8,000 fish would translate to approximately lethal take of 24 individuals.

There are three applicants who have requested take of adult salmon from northern California coastal ESUs; only one has requested lethal take. Phillip Barrington has requested lethal take of 15 SONCC coho salmon (800 nonlethal), 10 CC Chinook salmon (500 nonlethal), and 10 NC steelhead (250 nonlethal) for the operation of an adult fish trap on Freshwater Creek. However, as with juvenile fish, the request for lethal take for adults is function of total fish sampled and therefore less returning adults will translate into less lethal take. For example, Mr. Barrington is requesting a lethal take equal to 2 percent of fish handled non-lethally and therefore if 100 CC Chinook salmon are trapped, the potential mortality level may be 2 fish rather than 10.

NOAA Fisheries recognizes the potential increased impact to a salmon population from the take of adults. However, NOAA Fisheries expects the lethal take allotted to returning adult salmon in the Freshwater Creek watershed will not appreciably reduce the likelihood of the population's survival. Salmon populations are inherently resilient to the loss of a small percent of the population, even at the adult life stage (Spence et. al. 1996). Unless a population is reduced to just a few individuals, the loss of 1-2 percent of a returning adult population will not have a significant biological impact on the stability of that population (Dr. Terry Roloefs, Humboldt State University, pers. comm. December 2003). Furthermore, in spite of the operation of the adult fish trap for over 15 years, there has been a substantial increase in salmonid populations in the watershed since 1998.

The "Noyo River Juvenile Steelhead and Coho Salmon Abundance Estimation" (Project #10), is proposing to capture 100,000 juvenile NC steelhead, 10,000 juvenile CCC coho salmon, and 2,500 juvenile CC Chinook salmon from six locations on the Noyo River using fyke traps and electrofishing. Most of these fish will be young of year (YOY) fish, not smolts or adults. Unintentional lethal take requested is 3,000 juvenile NC steelhead, 113 juvenile CCC coho salmon, and 100 juvenile CC Chinook salmon. Survival rates for juvenile fish, especially YOY, is usually very low, so any unintentional lethal take that may occur is probably similar to what would occur naturally. This project accounts for 55 percent of the juvenile lethal take for NC steelhead, 44 percent of the juvenile lethal take for CCC coho salmon, and 4 percent of the juvenile lethal take for CC Chinook salmon. The amount of unintentional lethal take requested is expected to be an overestimate as the amount of actual mortality is usually less. The impact of this amount of take, if it even occurs, in the Noyo River should be minimal due to the fact that fish are quite abundant and widely distributed in this watershed. These fish have also shown a resilience to past disturbance. In fact, this study has been ongoing for over five years with no known significant impact to the population in this watershed. In addition, this study does not propose intentional lethal take and precautions will be required to minimize the chances of mortality to captured fish, further reducing the amount of potential fish loss.

The "South Central California Coast Salmon and Steelhead Restoration and Enhancement Program" (Project # 30), is proposing to capture 125 CCC coho salmon, 5,000 CCC steelhead and 5,000 SCCC steelhead from 90 randomly selected sites throughout California. Methods of capture will include electrofishing, seines, trapping, snorkeling and telemetry. There is no request for take of adults, only juvenile fish. This project accounts for 2 percent of the juvenile lethal take for CCC steelhead, 2 percent of the juvenile lethal take for CCC coho salmon, and 33 percent of the juvenile lethal take for SCCC steelhead in the Program. The amount of unintentional lethal take requested is expected to be an overestimate, as the amount of actual lethal take is usually less. CDFG fisheries biologist Jennifer Nelson has estimated the overall mortality rate resulting from predation within **outmigrant** traps at less than 0.5 percent. At least half of the fish captured from this project will be from outmigrant trapping so NOAA fisheries expects the actual mortality from the trapping surveys to be within the 0.5 percent range. In addition, this study does not propose intentional lethal take and precautions will be required to minimize the chances of mortality to captured fish, further reducing the amount of potential fish loss. These projects will also be so spread out over the various ESU's that the impact of any unintentional lethal take will likely be very low in any given creek.

2. Central Valley ESU's

Table 2b.
Estimated take of adult and juvenile fish for the Central Valley Evolutionarily Significant Units

	Adult			Juvenile					
Evolutionarily Significant Unit	**Non-lethal**	**Lethal**	**% Lethal take**	**Non-lethal**	**Lethal**	**% Lethal take**	Total **take**	% Adult take	% Juvenile take
Central Valley spring-run Chinook salmon	24,830	59	0.2	787,036	14,261	1.8	826,186	3.0	97.0
Central Valley steelhead	6,475	134	2.1	38,170	2,020	5.3	46,799	14.1	85.9

Two projects account for the majority of take of Central Valley spring-run Chinook salmon adult and juvenile fish estimated for the Program. The first project, #77 ("Butte and Big Chico Creeks spring-run Chinook salmon life history investigation"), accounts for 86 percent and 91 percent of lethal and nonlethal take, respectively, of juvenile fish, and 81 percent of nonlethal take of adult fish. The estimated take from this project is large and potentially would have the most impact to the CV spring-run Chinook salmon ESU as the result of the estimated take numbers and because the sampling sites are restricted to one stream (Table 3). However, the impacts of the project to the ESU is limited and affect juvenile fish only. For example, 100 percent of take of adult fish results from non-invasive snorkel and carcass surveys, and only 1.7 percent of the juvenile take is estimated to result in fish mortality. Juvenile fish will be captured, measured, and released (30 percent of which will be tagged) by experienced personnel to ensure minimal disturbance to the fish.

Butte Creek, the primary site of this project, has the largest of three sustaining populations of spring-run Chinook salmon, and is an important stream for establishing population trends for the ESU. Butte Creek supports a large adult population that has reached up to 20,259 in 1998, and most recently to 9,605 in 2001 (Ward and McReynolds 2002). Fry production in Butte Creek over the last decade has ranged from a low of 155,282 fry in 1994 to a high of 6,636,848 fry in 1998 (based on 52:48 female to male spawner ratio (Ward and McReynolds 2001); 4,200 eggs per female (CDFG 1998c); 15 percent egg to fry survival (Healy 1991)). The proportion of lethal take of juveniles resulting from this project, therefore, would approximate 8 percent to 0.2 percent of the population given the calculations for high and low population estimates mentioned above.

This specific study has been ongoing since 1995 during which the populations have continued to show an increasing trend (Ward and McReynolds 2001). The trend of increasing abundance of juvenile and adult fish suggests the scale of this project, and previous take of upwards of 8 percent of juvenile fish, has not had adverse effects on the Butte Creek population. This ongoing study may have had an effect on the population but the effect does not appear to be negative given the increase in fish abundance in recent years. The non-invasive method of adult take and the relatively low mortality rate resulting from take of juvenile fish is therefore not expected to be likely to jeopardize the existence of the population in Butte Creek or the ESU.

The second project, #39 ("Feather River Fisheries Research-Feather River Hatchery Fish Ladder Investigations"), accounts for 85 percent of the estimated lethal take for adult CV spring-run Chinook salmon. While this project may account for a large number of take of fish, the principal investigators have recently determined these numbers were overestimated. The investigators have found similar studies using the same study protocol to result in far less lethal take of salmon (e.g., 1 mortality out of 100 fish sampled; Anna Kastner, CDFG, personal communication, October 2003). The investigators have committed to implement study protocols that have been successful in reducing mortality, which would result in this project incurring lethal take of only a few adult fish based on the pilot study results. Take of a few adult fish (e.g., 1 percent of those captured) that may result from this project would not likely jeopardize the existence of populations in the Feather River, which is estimated to support a high of 6,833 adult CV spring-run Chinook salmon in 1988 and most recently supported an estimated 4,189 adult fish in 2002 (CDFG, unpublished data).

The project, "Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout, Otolith Analysis" (Project #25), accounts for 75 percent of the adult lethal take and 19 percent of juvenile lethal take of CV steelhead. This project will obtain most of the specimens from opportunistically collected carcasses and incidental mortalities resulting from other permitted research and monitoring projects and archived samples. Any additional needed specimens will be collected from a broad geographic region spanning a dozen Central Valley streams in the Sacramento and San Joaquin basins (see Table 3 for locations). Given the scenario that no otolith specimens are available from other projects, a maximum of 75 juvenile fish would be sacrificed from each of six streams over the course of a year. Such an amount may incur lethal take of 5 percent of the juvenile *O. mykiss* population in the Calaveras River, an example of one of the larger Central Valley streams with relatively low population numbers (e.g., 1606 juvenile fish based on S.P. Cramer unpublished data). This translates into 5 to 8 percent fewer fish returning as adults to spawn in the Central Valley using juvenile survival and adult return rates for Central Valley Chinook salmon (e.g., 5 percent lethal take in Calaveras River; 3 to 34 percent juvenile Chinook salmon survival rates in the Central Valley (Healy 1991); 0.35 percent Chinook salmon return as adults to spawn in Central Valley (USFWS 2001)). The impact of this project on Central Valley steelhead should be minimal given the general non-invasive nature of specimen collection, year-round sampling, and the broad geographic scope of sampling location.

E. Beneficial Effects of Approving CDFG's Program

NOAA Fisheries approves CDFG's Program on the basis of the Program's aim to conserve salmonids and meet their biological requirements, which are criteria set forth in the 4(d) rule for threatened salmonids. The use of ESA-listed species for scientific research is consistent with the purpose of the ESA when the research facilitates recovery of a listed species. The status reviews for ESA-listed salmonids within California lament the lack of data available for making satisfactory management decisions (Busby *et al.* 1996, NOAA Fisheries 1997a, Myers *et al* 1998). Data generated from CDFG's Program will be useful for the management and recovery of ESA-listed salmonids. Scientific information is necessary to reduce uncertainty in determining whether a consultation is to be conducted formally or informally, in determining whether an action jeopardizes a listed species and when developing terms and conditions, reasonable and prudent measures, and reasonable and prudent alternatives.

In order to facilitate the restoration and recovery of ESA-listed salmonids within the Coastal and the Central Valley of California, scientific research programs directed toward developing a more robust and complete body of information are needed. Resulting information from these types of research projects in the Program is valuable to reduce uncertainty in management decisions that might affect salmon. Also, monitoring activities can help NOAA Fisheries determine if protective actions are assisting in the recovery of listed species within the action area. Information from research activities can facilitate recovery. The risks to individual ESA-listed salmonids from the adverse effects of scientific research are minor when compared to the benefits that are expected from the issuance of research permits. As described above, the impacts to populations within the ESUs are not expected to be sufficient to reduce appreciably the likelihood of survival and recovery of those ESUs.

VI. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." For the purpose of this analysis, the action area includes all coastal California streams from north of the Santa Maria River in San Luis Obispo County to the Oregon/California border and streams draining into San Francisco and San Pablo bays, including the Sacramento-San Joaquin River Basin. Future Federal actions, including the ongoing operation of dams, hatcheries, fisheries, water withdrawals, and land management activities will be reviewed through separate ESA section 7 consultation processes and not considered here. Non-Federal actions which may affect listed species within the action area considered in this biological opinion include: urbanization, changes in agricultural practices or demand for agricultural products, changes in State hatchery practices, State angling regulations, gravel mining, forestry, and voluntary State or private sponsored habitat restoration activities. The following is a summary of potential cumulative effects that may affect the listed salmonids in the action area.

Tribal, State, and local government actions will likely be in the form of legislation, administrative rules or policy initiatives, and may encompass changes in land and water uses or intensity of use, which could impact listed species or their habitat. Tribal and government actions are subject to political, legislative, and fiscal uncertainties that will determine participation and, therefore, the effect such actions have on listed species. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the actions of many private landowners, make any analysis of cumulative effects difficult and speculative.

Tribal governments will continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. Tribal governments will need to put into practice comprehensive and beneficial natural resource programs if they are to have measurable positive effects on listed species and their habitat.

The state of California administers the allocation of water resources within its borders. State and local governments are cooperating with each other and Federal agencies to increase environmental protections, including better habitat restoration and hatchery and harvest reforms. NOAA Fisheries also cooperates with the State water resource management agencies in assessing water resource needs in the action area and in developing flow requirements that will benefit listed fish. During low-water years, however, there may not be enough flow to meet the needs of fish. Moreover, these government efforts could be reduced or even discontinued, so their cumulative effect on listed fish is unpredictable.

Local governments will be faced with similar, but more direct pressures from population growth and movement. The reaction of local governments to such pressures is difficult to assess at this time. In the past, local governments in the action area generally accommodated additional growth in ways that adversely affected listed fish habitat. Also, there is little consistency among local governments in dealing with land use and environmental issues, so any positive effects that local government actions have on listed species and their habitat are likely to be scattered throughout the action area.

A. Urbanization

California is projected to be the #1 state in the United States in projected growth of human populations in both percent change and numbers of individuals with nearly 18 million new residents, and a projected increase of more than 55 percent by 2025 (U.S. Census Bureau, www.census.gov). Increased human population will: place greater demands in the action area for electricity, water, and land with development potential; increase demand for waste disposal sites; affect water quality directly and indirectly; and increase the need for transportation, communication, and other infrastructure development. In addition, increasing water demands, which affects water quality and quantity, riparian function, and stream productivity, will continue to impact salmonid populations in the future throughout the action area. As anthropogenic effects are generally accepted as the major cause for the decline of salmonids within California watersheds, it does not seem likely that these effects will be lessened as the human population growth rate is high in California. Furthermore, the increasing demand for water will likely challenge CALFED's and Central Valley Project Improvement Act's ability to provide aquatic habitat for listed salmonid species.

The effects of private actions are the most uncertain. Private landowners may change, intensify, or diminish their current land and water uses, possibly impacting salmonids and their habitat. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may arise out of population growth and economic pressures. Changes in ownership patterns will have unknown impacts. NOAA Fisheries is unable to effectively predict the possible effects of private actions.

Increasing urbanization can also increase waste water discharges. Waste water discharges can result in negative thermal effects, associated organic input into aquatic systems, changes in aquatic invertebrate communities, increased algae and phytoplankton, and elevated coliform bacteria levels. Nonpoint source discharges are known to occur as a result of failing septic systems and other sources throughout the action area. Point source discharges occur at storm water drains or other discrete locations. Sediment input into streams results from bank slope failure along logged streams where vegetation has been removed or from unpaved roads that are poorly maintained. Discharges from identified point sources of wastewater are expected to be conducted under applicable State and Federal laws.

B. Water Withdrawals and Diversions

It is anticipated that environmental impacts from water withdrawals will continue at their present levels or increase as the result of the state's expected increase in population size. These impacts will include localized dewatering of stream reaches, entrapment of younger salmonids, and depletion of flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. Unprotected or poorly screened water diversions will continue to impact young salmonids with fry being drawn into water pumps or being stuck against the pump's screened intakes.

C. Agriculture

Agricultural activities within the action area include livestock grazing, dairy farming, and the cultivation of crops. The recent upward trend in the value of agricultural products is likely to continue as human populations increase. The impacts of this land use on aquatic species include decreased soil stability, loss of shade- and cover-producing riparian vegetation, increased sediment inputs, and elevated coliform bacteria levels. In addition, the placement of temporary dams, used to facilitate water supply for irrigation, may cause migrational barriers and habitat alteration for juvenile salmonids or create lentic habitats beneficial to normative predatory fish species.

D. Chemical Use

It is anticipated that chemicals such as pesticides, herbicides, fertilizers, and fire retardants will continue to be used in the action area. Impacts to salmonids may include changes to riparian vegetation and associated organic input into aquatic systems, changes in aquatic invertebrate communities, and increased algae and phytoplankton.

E. Hatcheries

State hatchery practices could reduce natural stocks of listed salmonids and their overall populations through competition, reduction in genetic diversity, and disease transmission resulting from hatchery introductions. However, the effects of hatchery practices on listed salmonids may also depend on other factors such as predation and habitat quantity and quality. Efforts are currently underway between NOAA Fisheries and the State to modify existing hatchery practices in ways to augment salmon and steelhead populations without having detrimental effects on naturally spawning populations. Through the close evaluation of practices at all anadromous fish hatcheries in California, the State is expected to determine the effects on wild populations and take steps to change hatchery practices if needed. In the future, NOAA Fisheries expects to consult on Federal hatchery activities. However until that time, these activities are part of the cumulative effects in the action area.

F. Angling

State angling regulations are generally moving towards greater restrictions to protect listed fish species. Through seasonal and area closures, greater numbers of adult listed fish are expected to complete their migration to upstream spawning areas. In general, these changes in State angling regulations are expected to increase populations of listed salmonids. Mass marking of juvenile anadromous fish produced at California fish hatcheries could allow for the implementation of selective ocean and in-river harvest. A selective fishery that targets only externally marked hatchery production and that releases naturally spawned fish may significantly reduce harvest rates on listed salmonids. However, if effort increases and the rate of by-catch of ESA-listed fish does not decline, then the negative effect of the fishery on ESA-listed fish may be amplified.

G. Stream Restoration Projects

Restoration activities may cause temporary increases in turbidity, alter channel dynamics and stability, and temporarily stress salmonids. Properly constructed stream restoration projects may increase available habitat, habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. NOAA Fisheries does not know how many stream enhancement projects are completed outside of the CDFG's program and cannot precisely predict the effects of these projects. The overall effects of these activities are expected to be temporary and localized and are considered beneficial to the long-term viability of salmonid populations.

H. Gravel Mining

It is anticipated that the environmental impacts associated with gravel mining will continue as California's increasing human population continues to place demands on this resource. These impacts include loss of suitable spawning gravels, decreased bedload movement, and increased levels of turbidity as well as direct loss of salmonid habitat due to river channel incision, bank erosion, habitat simplification, and tributary downcutting. The CDFG and NOAA Fisheries are in the process of developing and implementing a gravel mining policy within the action area. However, it is not anticipated that these efforts will lessen the impacts of gravel mining on salmonid populations for the near future.

I. Forestry

Although forestry was a significant industry in the action area prior to the 1990s, most current logging is restricted to the mountainous areas of the action area. Future timber harvest activities may have direct, indirect, and cumulative effects by degrading features identified as essential for salmonid habitat. Construction of private unsurfaced roads may be a significant source of sediment input into streams that are habitat for listed salmonids. The level of new road construction cannot be anticipated, but impacts from roads associated with timber harvest operations should decline due to the increased emphasis on protection of aquatic resources and implementation of higher standards for road construction, maintenance and use.

J. Summary

Non-Federal activities within the action area are expected to increase with the expected increase in human population over the next 25 years in California. Thus, NOAA Fisheries assumes that future private and State actions will continue within the action area, but at increasingly higher levels as population density climbs. The cumulative effects in the action area are difficult to analyze considering the large geographic scope of this opinion, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although State, tribal and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them "reasonably certain to occur" in its analysis of cumulative effects.

VII. INTEGRATION AND SYNTHESIS

Populations of coho salmon, Chinook salmon, and steelhead in California have declined drastically over the last century and some subpopulations of salmonids have been lost. Within the action area, there are eight ESUs of salmonids listed as threatened under the ESA. The current status of listed salmonids in California, based upon their risk of extinction, has not significantly improved since the species were listed and some may have deteriorated (NOAA Fisheries 2003). The current status demonstrates the need for actions which will assist in the recovery of all of the listed salmonids, and that if measures are not taken to reverse these trends, the continued existence of these species could be at risk.

A major cause of the decline of anadromous salmonids in California is the loss or severe decrease in quality and function of essential habitat. Most of this habitat loss and degradation has resulted from anthropogenic watershed disturbances caused by agriculture, water diversion, urban development, erosion and flood control, dams, forestry, and gravel mining. Most of this habitat degradation is associated with the loss of essential habitat components necessary for the survival of anadromous salmonids.

The present body of scientific information relative to the abundance, distribution, and genetic composition of anadromous salmonid populations in California is incomplete. This paucity of data limits the ability of managers to evaluate proposed recovery actions. In order to facilitate the restoration and recovery of ESA-listed salmonids in California, a mechanism directed toward developing a more robust and complete body of information is needed. The NOAA Fisheries has established protective regulations for threatened anadromous salmonids in California. The NOAA Fisheries has limited the prohibitions on take in those eight ESUs through three separate

4(d) rules so long as the take occurs as the result of a program that adequately protects the listed species and its habitat. The CDFG requested a limit to take prohibitions for specific research and monitoring activities affecting all ESUs of threatened anadromous salmonids in California. Information provided by these projects can improve the body of knowledge relative to coho salmon, Chinook salmon, and steelhead. Also, the information can help NOAA Fisheries determine if protective actions are assisting in the recovery of listed species in the action area.

The objective of this biological opinion is to determine whether issuance of an authorization to CDFG limiting take associated with research and monitoring activities will reduce appreciably the likelihood of both the survival and recovery of listed species in the wild by reducing the reproduction, numbers, or distribution of those species. Specific activities involving take of ESA-listed salmonids anticipated in the CDFG Program may include: surveys by direct observation, capture by standard fishery gears, tagging, and other activities necessary to conduct studies aimed at the recovery of the species. The effect of this proposed action will consist of temporary behavior modification and rare instances of physical damage and/or possible mortality as a result of harassment, capture, or handling of individual fish. The potential impacts to individual ESA-listed salmonids are expected to be confined to specific sampling sites within the action area.

NOAA Fisheries conducted an analysis on several projects with the highest potential of having an impact on salmonid populations in a given watershed and found that the impact from these individual projects would be minimal. All of the other projects anticipated impacts that were minor or impacts spread out over large areas so that salmonid populations in these watersheds would be also minimally impacted. Also, more than 98.5 percent of anticipated take will be nonlethal. Although proposed research activities may have an adverse impact on listed salmonids, NOAA Fisheries expects the salmonid populations to be resilient to these impacts because none of the projects affect the production potential as spawning and rearing habitat will not be affected by the proposed project. As a result, populations should be able to successfully rebound from the small amount of unintentional mortalities anticipated. NOAA Fisheries believes that the studies implemented after issuance of the permits will make a significant contribution to the body of scientific knowledge and assist in conservation and management decisions that may lead to the recovery of ESA-listed salmonids in coastal northern California.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of SONCC coho salmon, CCC coho salmon, CC Chinook salmon, CVSR Chinook salmon, NC steelhead, CCC steelhead, SCCC steelhead, and CV steelhead, the environmental baseline for the action area, the effects of the proposed research and monitoring activities, and the cumulative effects, it is NOAA Fisheries' biological opinion that authorization of CDFG's Program is not likely to jeopardize the continued existence of any of these species.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by NOAA Fisheries as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

No incidental take is anticipated. NOAA Fisheries proposes to exempt the actions described above as CDFG's Program from the take prohibitions implemented for the eight salmonid ESUs pursuant to section 4(d) of the ESA.

X. REINITIATION STATEMENT

This concludes formal consultation on the projects within the 2003-2004 CDFG Program. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

XI. LITERATURE CITED

Adams, P.B. 2000. Status Review Update for the Steelhead Northern California Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Fisheries Science Center, Tiburon, California, 11 pages.

Adams, N.S., D.W. Rondorf, S.D. Evans, and J.E. Kelly. 1998. Effects of Surgically and Gastrically Implanted Radio Transmitters on Growth and Feeding Behavior of Juvenile Chinook Salmon. Transactions of the American Fisheries Society 127(1):128-136.

Ainslie, B.J, J.R. Post, and A.J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. North American Journal of Fisheries Management 18:905-918.

Allen, M.A., and T.J. Hassler. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific southwest) - Chinook salmon. United States Fish and Wildlife Service Biological Report 82(11.49): 1-26.

Anderson, K.R. 1995. A status review of the coho salmon *(Oncorhynchus kisutch)* in California south of San Francisco Bay. Report to the Fish and Game Commission. California Department of Fish Game, Sacramento, California, 49 pages, plus appendices.

Association of Bay Area Governments. 1992. State of the estuary: a report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary prepared under Cooperative Agreement #CE-009486-02 with the U.S. Environmental Protection Agency by the Association of Bay Area Governments, Oakland, California.

Baigun, C.R., J.R. Sedell, and G.H. Reeves. 2000. Influence of water temperature in use of deep pools by summer steelhead in Steamboat Creek, Oregon (USA). Journal of Freshwater Ecology 15(2):269-279.

Baker, P., and F. Reynolds. 1986. Life history, habitat requirements, and status of coho salmon in California. Report to the California Fish and Game Commission, Sacramento, California.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) - steelhead. U.S. Fish and Wildlife Service Biological Report 82(11.60):1-21.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. State Water Resources Control Board, Fisheries Engineering Research Program Portland Oregon. Contract No. DACW57-68-C-006.

Bendock, T. and M.Alexandersdottir. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. North American Journal of Fisheries Management 13:540-549.

Bergman, P.K., K.B. Jefferts, H.F. Fiscus, and R. Hager. 1968. A preliminary evaluation of an implanted coded-wire fish tag. Washington Department of Fisheries. Fisheries Research Paper 3(l):63-84.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream Temperature and Aquatic Habitat: Fisheries and Forestry Interactions. Pages 191-232 *in* E.O. Salo, and T.W. Cundy, editors. Streamside Management: Forestry and Fishery Interactions, Contribution No. 57: University of Washington, College of Forest Resources, Seattle, Washington.

Bilby, R.E., and P.A. Bisson. 1998. Function and distribution of large woody debris. Pages 324-346 *in* R. Naiman and R.E. Bilby, editors. River and Stream Ecology. Springer-Verlag. New York, New York.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland, 751 pages.

Boles, G. 1988. Water temperature effects on Chinook salmon *(Oncorhynchus tshawytscha)* with emphasis on the Sacramento River: a literature review. Report to the California Department of Water Resources. Northern District, 43 pages.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. State of California Department of Fish and Game, Fish Bulletin 94:1-63.

Brett, J.R. 1952. Temperature tolerance in young Pacific salmon, genus *Oncorhynchus.* Journal of the Fisheries Research Board of Canada 9:265-323.

Brown, L.R., and P.B. Moyle. 1991. Status of coho salmon in California. Report to the National Marine Fisheries Service, Northwest Region, Portland, Oregon, 114 pages.

Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. North American Journal of Fisheries Management 14(2):237-261.

Brungs, W.A., and B.R. Jones. 1977. Temperature criteria for freshwater fish: protocol and procedures. United States Environmental Protection Agency, Environmental Research Laboratory, EPA-600/3-77-061, Duluth, Minnesota.

Bryant, M.D. 1980. Evolution of large, organic debris after timber harvest: Maybeso Creek, 1949 to 1978, U. S. Dept of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 30 pages.

Buckley, R.M. and H.L. Blankenship. 1990. Internal extrinsic identification systems: overview of implanted wire tags, otolith marks, and parasites. American Fisheries Society Symposium 7:173-182.

Busby, P.J., T.C. Wainwright, G.J. Bryant., L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. Department of Commerce, National Oceanic and Atmospheric Administration Technical Memo NMFS-NWFSC-27, 261 pages.

CALFED Bay-Delta Program. 2000. Ecosystem Restoration Program Plan. Vol. I: Ecological Attributes of the San Francisco Bay-Delta Watershed. Final Programmatic EIS/EIR technical appendix, July 2000. Sacramento, California.

California Advisory Committee on Salmon and Steelhead Trout. 1988. Restoring the balance. Annual Report 124-J, 84 pages. [Available from California Advisory Committee on Salmon and Steelhead Trout, 120 Schoonmaker Point, Sausalito, California 94965.]

California Department of Fish and Game. 1965. California Fish and Wildlife Plan, Volume I: Summary. 110 pages; Volume II: Fish and Wildlife Plans, 216 pages; Volume III: Supporting Data, 180 pages.

California Department of Fish and Game. 1994. Petition to the California Board of Forestry to list coho salmon *(Oncorhynchus kisutch)* as a sensitive species. California Department of Fish and Game Report, 35 pages, plus appendices. [Available from California Board of Forestry, 1416 Ninth, Sacramento, California 95814.]

California Department of Fish and Game. 1997. Eel River Salmon and Steelhead Restoration Action Plan. Final Review Draft, January 28, 1997. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

California Department of Fish and Game. 1998a. California Salmonid Stream Habitat Restoration Manual. Third Edition. Inland Fisheries Division. California Department of Fish and Game. Sacramento, California, 495 pages.

California Department of Fish and Game. 1998b. A status review of the spring run Chinook salmon in the Sacramento River drainage. Report to the Fish and Game Commission. Candidate species status report 98-1. June 1998. Sacramento, California.

California Department of Fish and Game. 1998c. Report to the Fish and Game Commission: A status review of the Spring-run Chinook salmon *(Oncorhynchus tshawytscha)* in the Sacramento River drainage. Prepared by the Department of Fish and Game. Candidate Species Status Report 98-01.

California Department of Fish and Game. 2002. Status review of California coho salmon north of San Francisco. Report to the California Fish and Game Commission. Candidate Species Status Review Report 2002-3, 232 pages, plus appendices.

California Department of Fish and Game. 2003 a. Freshwater Sport Fishing Regulations Booklet. Prepared for the Fish and Game Commission by California Department of Fish and Game, Sacramento, California, 64 pages.

Hubert, W.A. 1996. Passive capture techniques. Pages 157-192 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques. Second Edition. American Fisheries Society. Bethesda, Maryland, 732 pages.

Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, assessment, and research on Central Valley steelhead: status of knowledge, review existing programs, and assessment needs. In Comprehensive Monitoring, Assessment, and Research Program Plan, Tech. Appendix VII.

Jenkins, W.E. and T.I.J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. American Fisheries Society Symposium 7:341-345.

Johnson, M.L. 1964. San Lorenzo River System, Santa Cruz County. California Department Fish and Game, Region 3, unpublished report, 8 pages. [Available from the Administrative Record for coho salmon in Scott and Waddell Creeks, National Marine Fisheries Service, Southwest Region Office, 501 W. Ocean Boulevard, Suite 4200, Long Beach, California 90802-4213.]

Johnson, S.L. 1988. The effects of the 1983 El Nino on Oregon's coho *(Oncorhynchus kisutch)* and Chinook *(O. tshawytschd)* salmon. Fisheries Research 6:105-123.

Jones and Stokes Associates, Incorporated. 1993. Strategies, potential sites, and site evaluation criteria for restoration of Sacramento River fish and wildlife habitats, Red Bluff to the Feather River. Prepared for the U.S. Army Corps of Engineers, Sacramento, California, 30 pages.

Kamler J.F. and K.L. Pope. 2001. Nonlethal methods of examining fish stomach contents. Reviews in Fisheries Science 9:1-11.

Keller, E.A. and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surface Processes 4:361-380.

Kelsch, S.W. and B. Shields. 1996. Care and handling of sampled organisms. Pages 121-156 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society. Bethesda, Maryland, 732 pages.

Kohler, C.C. and W.A. Hubert. 1993. Inland Fisheries Management in North America. American Fisheries Society. Bethesda, Maryland, 593 pages.

Kondolf, G.M. 1997. Hungry Water: Effects of Dams and Gravel Mining on River Channels. Environmental Management 21:533-551.

Kostow, K. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Department of Fish and Wildlife, Portland, Oregon, 217 pages, plus appendices.

Leidy, R.A. 1997. Estuary Report June 1997. United States Environmental Protection Agency. San Francisco Estuary Project.

Leidy, R.A., and G.R. Leidy. 1984. Life Stage periodicities of anadromous salmonids in the Klamath River Basin, northwestern California. United States Fish and Wildlife Service, Sacramento, California, 38 pages.

Leopold, L.B. 1968. Hydrology for urban land planning - A guidebook on the hydrologic effects on urban land use. United States Geologic Service Circular 554, 18 pages.

Light, J.T. 1987. Coastwide abundance of North American steelhead trout. (Document submitted to the annual meeting of the INPFC, 1987.) Fisheries Research Institute Report FRE-UW-8710. University of Washington, Seattle, Washington, 18 pages.

Maahs, R.P., S.A. Dressing, J. Spooner, M.D. Sniolen and F.J. Himenik. 1984. Best management practices for agricultural nonpoint source control-IV. Pesticides. National Water Quality Evaluation Project Report. North Carolina University, Raleigh, North Carolina, 87 pages.

Mantua, N.J. and S.R. Hare. 2002. The Pacific Decadal Oscillation. Journal of Oceanography 58 (l):35-44.

Matthews, K.R. and R.H. Reavis. 1990. Underwater tagging and visual recapture as a technique for studying movement patterns of rockfish. American Fisheries Society Symposium 7:168-172.

McEwan, D. 2001. Central Valley steelhead. Contributions to the biology of Central Valley salmonids. California Department of Fish and Game Fish Bulletin 179(l):l-44.

McEwan, D. and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, California, 234 pages.

McGill, R.R. Jr. 1979. Land use changes in the Sacramento River riparian zone, Redding to Colusa. Department of Water Resources, Northern District, 23 pages.

McGill, R.R. Jr. 1987. Land use changes in the Sacramento River riparian zone, Redding to Colusa. A third update: 1982-1987. Department of Water Resources, Northern District, 19 pages.

McMahon, T.E. 1983. Habitat suitability index models: coho salmon. United States Fish and Wildlife Service, FWS/OBS-82/10.49:1-29.

McMichael, G.A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13:229-233.

McMichael, G.A., L.F. Anthony, and T.N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management 18:894–904.

Meehan, W.R. and T.C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland, 751 pages.

Meehan, W.R., and R.A. Miller. 1978. Stomach flushing: effectiveness and influence on survival and condition of juvenile salmonids. Journal of the Fisheries Research Board of Canada 35:1359-1363.

Meehan, W.R. 1996. Influence of riparian canopy on macroinvertebrate composition and food habits of juvenile salmonids in several Oregon streams. Research Paper PNW-RP-496. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon, 14 pages.

Mellas, E.J. and J.M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): effects of attaching telemetry transmitters. Canadian Journal of Fisheries and Aquatic Sciences 42:488-493.

Moring, J.R. 1990. Marking and tagging intertidal fishes: review of techniques. American Fisheries Society Symposium 7:109-116.

Murphy, B.R. and D.W. Willis, editors. 1996. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland, 732 pages.

Murphy, G.I., and L. Shapovalov. 1951. A preliminary analysis of northern California salmon and steelhead runs. California Fish and Game 37(4):497-507.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. Technical Memorandum NMFS-NWFSC-35. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 443 pages.

Nakamoto, R.J. 1994. Characteristics of pools used by adult summer steelhead oversummering in the New River, California. Transactions of the American Fisheries Society 123:757-765.

National Marine Fisheries Service. 1996. Endangered Species Act - Section 7 consultation, biological opinion, The fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California of the Pacific Fishery Management Council.

National Marine Fisheries Service. 1997a. Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. NOAA Fisheries, Southwest Region, Long Beach, California, 228 pages, plus appendices.

National Marine Fisheries Service. 1997b. Reinitiated Section 7 Consultation on the Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as it Affects the Sacramento River Winter Chinook Salmon.

National Marine Fisheries Service. 2000. Endangered Species Act - Reinitiated Section 7 Consultation, Biological Opinion and Incidental Take Statement. Effects of the Pacific Coast Salmon Plan on California Central Valley Spring-Run Chinook and California Coastal Chinook Salmon.

National Marine Fisheries Service. 2001a. Status review update for coho salmon *(Oncorhynchus kisutch)* from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 111 pages.

National Marine Fisheries Service. 2002a. Endangered Species Act - Reinitiated Section 7 Consultation, Supplemental Biological Opinion and Incidental Take Statement. Effects of the Pacific Coast Salmon Plan During the 2002 and 2003 Fishing Seasons on Sacramento River Winter Chinook Salmon.

National Marine Fisheries Service. 2002b. Endangered Species Act - Reinitiated Section 7 Consultation, Interim Operations of the Central Valley Project and State Water Project between April 1, 2002 and March 31, 2004.

National Marine Fisheries Service. 2003. Draft Report of Updated Status of Listed ESUs of Salmon and Steelhead. NOAA Fisheries, Northwest Fisheries Science Center, Seattle, Washington. (http://www.nwfsc.noaa.gov/cbd/trt/brt/brtrpt.html)

Nehlson, W., J.E. Williams, and L.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16:4-21.

Nielsen, J.L. 1992. Microhabitat-specific foraging behavior, diet, and growth of juvenile coho salmon. Transactions of the American Fisheries Society 121:617-634.

Nielsen, J.L., T.E. Lisle, and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in Northern California streams. Transactions of the American Fisheries Society 123:613-626.

Nielsen L.A. and D.L. Johnson, editors. 1983. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland, 468 pages.

Osborne, L.L., and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water-quality restoration and stream management. Freshwater Biology 29(2):243-258.

Page, L.M., and B.M. Burr. 1991. A Field Guide to the Freshwater Fishes of North America North of Mexico. The Peterson Field Guide Series, Houghton Mifflin Company, Boston, Massachusetts, 432 pages.

Pearcy, W.G. 1992. Ocean ecology of North Pacific salmonids. University of Washington Press, Seattle, Washington, 179 pages.

Phillips, R.W. and H.J. Campbell, 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Annual Report of the Pacific Marine Fisheries Commission 14:60-73.

Powell, M.A. 1997. Water-quality concerns in restoration of stream habitat in the Umpqua basin. Pages 129-132 *in* J.D. Hall, P.A. Bisson and R.E. Gresswell, editors. Sea-run Cutthroat Trout: Biology, Management, and Future Conservation. American Fisheries Society, Oregon Chapter, Corvallis, Oregon.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7:317-322.

Prentice, E.F., D.J. Maynard, S.L. Downing, D.A. Frost, M.S. Kellett, D.A. Bruland, P. Sparks-McConkey, F.W. Waknitz, R.N. Iwamoto, K. McIntyre, and N. Paasch. 1994. A study to determine the biological feasibility of a new fish tagging system (1990-93). United States Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon. Project Number 83-3 19, Report DOE/BP-11982-5.

Prolysts, Incorporated and Beak Consultants, Incorporated. 1984. Coyote Valley Dam fish mitigation study. Prepared for the United States Army Corps of Engineers, Sacramento, California.

Reavis, B. 1991. Status of California steelhead stocks. Pages 57-63 *in* Pacific States Marine Fisheries Commission and Association of Northwest Steelheaders (organizers), International Symposium on Steelhead Trout Management, January 3-5, 1991, Portland, OR.

Reid, L.M. 1994. Evaluating timber management effects on beneficial uses in Northwest California, Arcata, Pacific Southwest Research Station. Report to the California Department of Fire and Forestry Protection, 164 pages.

Reiser, D.W., and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. United States Department of Agriculture Forest Service General Technical Report PNW-96, 54 pages.

Reiser, D.W., and R.G. White. 1988. Effects of two sediment size-classes on survival of steelhead and Chinook salmon eggs. North American Journal of Fisheries Management 8:432-437.

Richter, B.D., D.P. Braun, M.A. Mendelson, and L.L. Master. 1997. Threats to imperiled freshwater fauna. Conservation Biology 11:1081-1093.

Rutter, C. 1904. Natural history of the quinnat salmon. A report of investigations in the Sacramento River, 1896-1901. Bulletin of the United States Fish Commission 22:65-141.

Salo, E., and W.H. Bayliff. 1958. Artificial and natural production of silver salmon, *Oncorhynchus kisutch,* at Minter Creek, Washington. Washington Department of Fisheries Research Bulletin 4, Washington Department of Fish and Wildlife, Olympia, Washington, 76 pages.

Sandercock, F.K. 1991. Life history of coho salmon *(Oncorhynchus kisutch).* Pages 395-445 *in* C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, British Columbia, 564 pages.

Schiewe, M. H. 1996a. Conclusions regarding the updated status of West Coast coho salmon. Memorandum dated December 20, 1996. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Schiewe, M. H. 1996b. Supplemental report of the Biological Review Team on Central California Coast coho salmon. Memorandum dated October 17, 1996. United States

Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Schiewe, M. H. 1997. Memorandum to William Stelle and William Hogarth: status review update for West Coast steelhead from Washington, Idaho, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Scott, W.B., and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, 966 pages.

Shapovalov, L. and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri)* and silver salmon *(Oncorhynchus kisutch)* with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin 98:1-375.

Sharber, N.G. and S.W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N.G., S.W. Carothers, J.P. Sharber, J.C. de Vos, Jr., and D.A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Shirazi, M.A., and W.K. Seim. 1979. Stream Systems Evaluation - An Emphasis on Spawning Habitat for Salmonids. United States Environmental Protection Agency, Portland, Oregon. Technical report EPA-600/3-79-109, 45 pages.

Shirvell, C.S. 1990. Role of instream rootwads as juvenile coho salmon *(Oncorhynchus kisutch)* and steelhead trout *(O. mykiss)* cover habitat under varying streamflows. Canadian Journal of Fisheries and Aquatic Sciences 47:852-860.

Slater, D.W. 1963. Winter-run Chinook salmon in the Sacramento River, California with notes on water temperature requirements at spawning. U.S. Fish and Wildlife Service Special Scientific Report - Fisheries 461.

Smith, A.K. 1973. Development and application of spawning velocity and depth criteria for Oregon salmonids. Transactions of the American Fisheries Society 10(2):312-316.

Smith, E.M., B.A. Miller, J.D. Rodgers, M.A. Buckman. 1985. Outplanting anadromous salmonids: a literature survey. United States Department of Energy, Contract number DE-A179-85P23109. Bonneville Power Administration. Portland, Oregon, 68 pages.

Smith, J. J. 2001. Distribution and abundance ofjuvenile coho and steelhead in Gazos, Waddell and Scott creeks in 2001. Unpublished report available from Dr. Jerry Smith, Department of Biological Sciences, San Jose State University, San Jose, California, 9 pages, plus appendices.

Snyder, D.E. 1992. Impacts of electrofishing on fish. American Fisheries Society Fisheries Management Section Newsletter 12:5-6.

Snyder, D.E. 1995. Impacts of electrofishing on fish. Fisheries 20:26-27.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, R.P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. Management Technology, Corvallis, Oregon, 356 pages.

Sprague, C.R., L.G. Beckman, and S.D. Duke. 1993. Prey selection by juvenile white sturgeon in reservoirs of the Columbia River. Pages 229-243 *in* R.C. Beamsderfer and A.A. Nigro, editors. Status and habitat requirements of the white sturgeon populations in the Columbia River downstream from McNary Dam, volume 2. Final Report on the Oregon Department of Fish and Wildlife to Bonneville Power Administration, Portland, Oregon.

Standiford, R.B. and R. Arcilla. 2001. A scientific basis for the prediction of cumulative watershed effects. University of California Wildland Resource Center Report No. 46.

Stein, R.A., P.E. Reimers, and J.D. Hall. 1972. Social interaction between juvenile coho *(Oncorhynchus kisutch)* and fall Chinook salmon *(O. tshawytschd)* in Sixes River, Oregon. Journal of the Fisheries Research Board of Canada 29:1737-1748.

Steiner Environmental Consulting. 1996. A history of the salmonid decline in the Russian River. Steiner Environmental Consulting, Potter Valley, California, 94 pages.

Stickney, R.R. 1983. Care and handling of live fish. Pages 85-94 *in* L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland, 468 pages.

Stone, L. 1874. Report of operations during 1872 at the United States salmon-hatching establishment on the McCloud River, and on the California Salmonidae generally, with a list of specimens collected. United States Commission of Fish and Fisheries, Report for 1872 and 1873:168-215. Washington, D.C.

Summerfelt. R.C. and L.S. Smith. 1990. Anesthesia, surgery, and related techniques. Pages 213-172 *in* C.B. Schreck and P.B. Moyle, editors. Methods for Fish Biology. American Fisheries Society, Bethesda, Maryland, 684 pages.

Swanson, F.J. and G.W. Lienkaemper. 1978. Physical consequences of large organic debris in pacific northwest streams. General Technical report PNW-69. USDA Forest Service, Pacific Northwest forest and range experiment station, Portland, Oregon.

Tappel, P.D., and T.C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North American Journal of Fisheries Management 3:123-135.

Thompson, K. 1972. Determining stream flows for fish life. Proceedings, Instream Flow Requirement Workshop. Pacific Northwest River Basin Commission, Vancouver, Washington.

Thompson, K.G., E.P. Bergersen, R.B. Nehring, and D.C. Bowden. 1997. Long-term effects of electrofishing on growth and body condition of brown trout and rainbow trout. North American Journal of Fisheries Management 17:154-159.

United States Army Corps of Engineers. 1982. Northern California Streams Investigation Russian River Basin Study. Final Report. San Francisco, California. United States Army Corps of Engineers, San Francisco, California.

United States Department of the Interior. 1999. Final Programmatic Environmental Impact Statement for the Central Valley Project Improvement Act. October 1999. Technical Appendix, 10 volumes.

United States Fish and Wildlife Service. 2001. Biological Assessment of Artificial Propagation at Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery: program description and incidental take of Chinook salmon and steelhead trout. Prepared by U.S. Fish and Wildlife Service Red Bluff Fish and Wildlife Office, Red Bluff, California.

Waples, R.S. 1991. Pacific Salmon, *Oncorhynchus spp.,* and the definition of "species" under the Endangered Species Act. Marine Fisheries Review 53:11-21.

Ward, P.D. and T.R. McReynolds. 2001. Butte and Big Chico Creeks spring-run Chinook salmon, *Oncoryhnchus tshawytscha* life history investigation, 1998-2000. California Department of Fish and Game. Inland Fisheries Administrative Report No. 2001-2, 61 pages.

Ward, P.D. and T.R. McReynolds. 2002. Sacramento River spring run Chinook salmon, 2001 annual report. California Department of Fish and Game, Habitat Conservation Division, Native Anadromous Fish and Watershed Branch, Sacramento, California, 29 pages.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon, and California.

Technical Memorandum NMFS-NWFSC-24. United States Department of Commerce, National Oceanic and Atmospheric Administration, 258 pages.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. Bioscience 1998:607-615.

Yoshiyama, R.M., E.R.Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress. Pages 309-362 *in* Volume 3. Assessments, commissioned reports, and background information. University of California, Center for Water and Wildland Resources, Davis.

XIII. FEDERAL REGISTER NOTICES CITED

Volume 61 pages 56138-56149. October 31, 1996. National Marine Fisheries Service. Final Rule: Threatened Status for Central California Coast Coho Salmon Evolutionary Significant Unit.

Volume 62 pages 1296-1297. January 9, 1997. National Marine Fisheries Service. Correction: Threatened Status for Central California Coast Coho Salmon Evolutionarily Significant Unit (ESU).

Volume 62 pages 24588-24609. May 6, 1997. National Marine Fisheries Service. Final Rule: Threatened Status for Southern Oregon/Northern California Coasts Evolutionary Significant Unit of Coho Salmon.

Volume 62 pages 38479-38485. July 18, 1997. National Marine Fisheries Service. Interim Rule Governing Take of the Threatened Southern Oregon/Northern California Coast Evolutionarily Significant Unit (ESU) of Coho Salmon.

Volume 62 pages 43937-43954. August 18, 1997. National Marine Fisheries Service. Final Rule: Listing of Several Evolutionary Significant Units of West Coast Steelhead.

Volume 63 pages 13347-13371. March 19, 1998. National Marine Fisheries Service. Final Rule: Endangered and Threatened Species: Threatened Status for Two ESUs of Steelhead in Washington, Oregon, and California.

Volume 64 pages 24049-24062. May 5, 1999. National Marine Fisheries Service. Final Rule and Correction: Designated Habitat for Central California Coast Coho and Southern Oregon/Northern California Coast Coho Salmon.

Volume 64 pages 50394-50415. November 15, 1999. National Marine Fisheries Service. Final Rule: Threatened Status for Two Chinook Salmon Evolutionary Significant Units in California.

Volume 65 pages 42422-42481. July 10, 2000. National Marine Fisheries Service. Final Rule: Governing Take of 14 Threatened Salmon and Steelhead Evolutionary Significant Units.

Volume 65 pages 7764-7787. February 16, 2000. National Marine Fisheries Service. Final Rule: Designated Habitat for 19 Evolutionary Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.

Volume 65 pages 36074-36094. June 7, 2000. National Marine Fisheries Service. Final Rule: Threatened Status for One Steelhead Evolutionarily Significant Unit (ESU) in California.

Volume 65 pages 42422-42481. July 10, 2000. National Marine Fisheries Service. Final Rule: Governing Take of 14 Threatened Salmon and Steelhead Evolutionary Significant Units.

Volume 67 pages 1116-1133. January 9, 2002. National Marine Fisheries Service. Final Rule: Governing Take of Four Threatened Evolutionarily Significant Units (ESUs) of West Coast Salmonids.

Table 1. References for additional background on listing status, critical habitat, protective regulations, and biological information for the listed species addressed in this document.

ESU	Listing Status	Critical Habitat	Protective Regulations	Biological Information
Southern Oregon/Northern California Coast *(Oncorhynchus kisutch)*	Threatened May 6, 1997 62 FR 24588	May 5, 1999 64 FR 24049	Jul 18, 1997 62 FR 38479	Hassler 1987; Sandercock 1991; Weitkamp *et al.* 1995; NOAA Fisheries 2001
Central California Coast coho salmon *(Oncorhynchus kisutch)*	Threatened Oct 31, 1996 61 FR 56138 Jan 9, 1997. 62 FR 1296[2]	May 5, 1999 64 FR 24049	Oct 31, 1996 61 FR 56138; Jan 9, 2002 67 FR 1116[3]	Shapovalov & Taft 1954; Hassler 1987; Sandercock 1991; Weitkamp *et al.* 1995; NOAA Fisheries 2001; NOAA Fisheries 2003
California Coastal Chinook salmon *(Oncorhynchus tshawytscha)*	Threatened Sep 16, 1999 64 FR 50394	Feb 16, 2000 65 FR 7764[4]	Jan 9, 2002 67 FR 1116	Allen and Hassler 1986; Healey 1991; Myers *et al.* 1998; NOAA Fisheries 1999; NOAA Fisheries 2003
Central Valley Spring-run Chinook salmon *(Oncorhynchus tshawytscha)*	Threatened Sep 16, 1999 64 FR 50394	Feb 16, 2000 65 FR 7764[3]	Jan 9, 2002 67 FR 1116	Allen and Hassler 1986; Healey 1991; Myers *et al.* 1998; NOAA Fisheries 1999; NOAA Fisheries 2003
Northern California steelhead *(Oncorhynchus kisutch)*	Threatened Jun 7, 2000 65 FR 36074	not designated	Jan 9, 2002 67 FR 1116	Barnhart 1986; Busby *et al.* 1996; NOAA Fisheries 1997; NOAA Fisheries 2003
Central California Coast steelhead *(Oncorhynchus kisutch)*	Threatened Aug 18, 1997 62 FR 43937	Feb 16, 2000 65 FR 7764[3]	Jul 10, 2000 65 FR 42422	Shapovalov & Taft 1954; Barnhart 1986; Busby *et al.* 1996; NOAA Fisheries 1997; NOAA Fisheries 2003
South Central California Coast steelhead *(Oncorhynchus kisutch)*	Threatened Aug 18, 1997 62 FR 43937	Feb 16, 2000 65 FR 7764[3]	Jul 10, 2000 65 FR 42422	Shapovalov & Taft 1954; Barnhart 1986; Busby *et al.* 1996; NOAA Fisheries 1997; NOAA Fisheries 2003
Central Valley steelhead *(Oncorhynchus kisutch)*	Threatened Mar 19, 1998 63 FR 13347	Feb 16, 2000 65 FR 7764[4]	Jul 10, 2000 65 FR 42422	Barnhart 1986; Busby *et al.* 1996; NOAA Fisheries 1997; McEwan 2001; NOAA Fisheries 2003

[2] In a technical correction to the final listing determination, NOAA Fisheries defined the CCC coho salmon ESU to include all coho salmon naturally-reproduced in streams between Punta Gorda in Humboldt County, California, and the San Lorenzo River in Santa Cruz County, California (inclusive), and included tributaries to San Francisco Bay.

[3] NOAA Fisheries modified protective regulations for the threatened Central California Coast CCC coho salmon ESU to incorporate additional limits on the application of the take prohibitions.

[4] On April 30, 2002, critical habitat designation for the CC and CVSR Chinook salmon ESU, and SCCC, CCC, and CV steelhead ESU, among others, was vacated by the Washington D.C. District Court, resolving claims challenging the process by which NOAA Fisheries designates critical habitat.

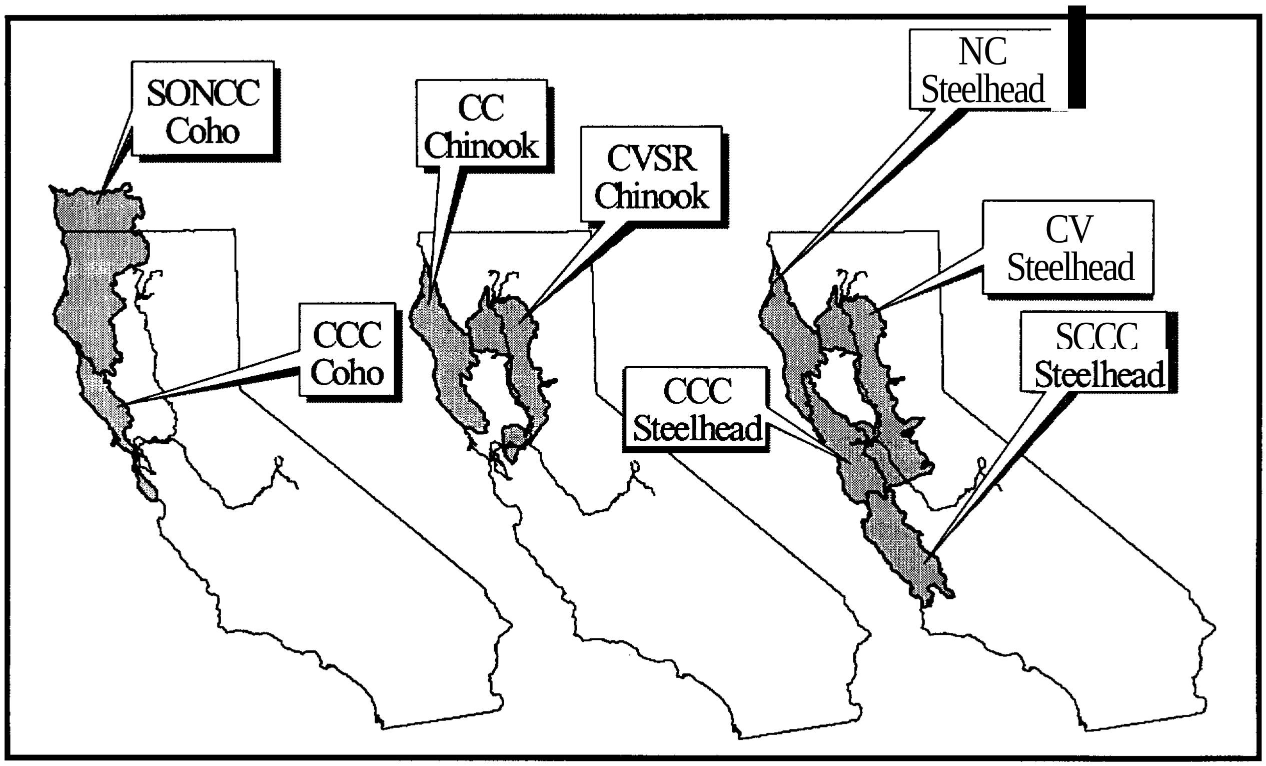

Figure 1. Maps illustrating the geographic and relative positions of various Evolutionarily Significant Units of salmonids in California. Specific boundaries of the featured Evolutionarily Significant Units are described in final listing determinations referenced in Table 1.

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. California Coast coho salmon adult non-lethal	adult lethal	juv non-lethal	juv lethal	Central California Coast coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	California Coastal Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Northern California steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
1	William Mitchell (916) 737-3000	Jones & Stokes	Life History and Stock Composition of Steelhead Trout in the Lower Yuba River	Life history	Analyze scales and otoliths from migrating adult steelhead to 1) characterize life history patterns, 2) assess run composition re: origin and life history pattern, 3) develop scale classification criteria for determining age, life history, and origin of C	Upstream migrant trap	Handle, scale sample	Year-round	Yuba River	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Walt Duffy (707) 826-5644	USGS California Cooperative Fish Research Unit, Humboldt State University	Demographics of Coho Salmon in northern California streams of varying habitat quality	Monitor for presence and relative abundance of fish	Relate abundance of salmonids to characteristics of stream restoration projects.	Capture methods include traps, direct observation, and electrofishing.	Capture, handle, and release	Year round	ESU wide	Yes	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,000	50
3	Walt Duffy (707) 826-5644	USGS California Cooperative Fish Research Unit, Humboldt State University	Coastal Watershed Restoration Validation Monitoring Development	Monitor for presence and relative abundance of fish	Relate abundance of salmonids to characteristics of stream restoration projects.	Capture methods include traps, direct observation, and electrofishing.	Capture, handle, and release	Year round	ESU wide	Yes	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,000	30
4	Steve Baumgartner, Tim Heyne Sbaumgartner@dfg.ca.gov, Theyne@dfg.ca.gov	CDFG	Mossdale Kodiak Trawl Operation	Smolt production and survival	Calculate indices and estimate of fall-run Chinook smolt production and survival in the South Delta.	Kodiak trawl	Handle	Mar-Jun	San Joaquin @ Mossdale	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Scott Harris (707) 459-2238	CDFG	North Central District Salmon and Steelhead Resource Assessment	monitoring and stream surveys,	monitor trends in salmonid abundance and population size	downmigrant trapping and electrofishing	Capture, handle, and release	as needed	Eel River, Russian River, Mendocino Coastal Basins	No	No	0	0	0	0	0	0	7,000	5	0	0	700	0	0	0	5,000	4
6	Sandy Borthwick (530) 528-0512	USBOR	Monitoring of Fish Entrainment at Red Bluff Research Pumping Plant	Fish entrainment	Monitor fish entrainment at RBRPP	Fish pump, holding tank	Handle	[illegible]	Sacramento River at Red Bluff	Yes	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Robert Leidy (415) 972-3463	USEPA	Distributional status and ecology of stream fishes of the San Francisco Estuary, California	Determine the distributional status and ecology of freshwater fishes of streams of the San Francisco estuary	Studying status and ecology of fish	Methods include electrofishing, minnow or beach seine, or dip net.	Capture, handle, take tissues	year round	San Francisco Estuary	Yes	No	0	0	0	0	0	0	5	0	0	0	0	0	0	0	200	5
8	Robert Leidy (415) 972-3463	USEPA	Federal Clean Water Act, Section 404, Enforcement Investigations	Aquatic habitat sampling	Investigate unpermitted discharges in water bodies.	Electrofisher, minnow or beach seine, or dip net.	Capture, handle, take tissues	as needed	as needed	Yes	No	0	0	0	0	0	0	5	0	0	0	10	0	0	0	50	2
9	Phillip Barrington (707) 825-4850	CDFG	1a1: Freshwater Creek Adult Salmonid Studies	migration survey	[illegible]	Permanent weir	capture/handle/tag	winter/spring	Freshwater Creek	No	No	800	15	0	0	0	0	0	0	500	10	0	0	250	10	0	0
10	Phillip Barrington (707) 825-4850	CDFG	2a2: Noyo River Juvenile Steelhead and Coho Salmon Abundance	Stream surveys	Estimate juvenile abundance	electrofishing and fyke trap	capture/handle/tag	spring	Noyo River	No	No	0	0	0	0	0	0	10,000	113	0	0	2,500	100	0	0	100,000	3,000

Project Number	Point of Contact	[illegible]	Project Title	Project Description	Project Objective	Project Gear	Take Activity	[illegible]	River System	Federal Nexus	[illegible] by DFG	Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	[illegible] California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley spring-run Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
1	William Mitchell (916) 737-3000	Jones & St[illegible]s	Life History and Stock Composition of Steelhead Trout In the Lower Yuba River	Life history	Analyze scales and otoliths from migrating adult steelhead to 1) characterize life history patterns, 2) assess run composition re: origin and life history pattern, 3) develop scale classification criteria for determining age, life history, and origin of [illegible]	Upstream-migrant trap	Handle, scale sample	Year-round	[illegible]iver	No	Yes	0	0	0	0	0	0	0	0	[illegible]	4	0	0	500	10	0	0
2	Walt Duffy (707) [illegible]5644	USGS California Cooperative Fish Research Unit, Humboldt State University	Demographic of [illegible] Salmon in northern California streams of varying habitat quality	Monitor for presence and relative abundance of fish	Relate abundance of salmonids to characteristics of restoration project	Capture methods include traps, direct observation, and electrofishing.	Capture, handle, and release	Year round	[illegible]	Yes	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	[illegible] (707) 8[illegible]	USGS California Cooperative Fish Research Unit, Humboldt State University	Coastal Watershed Restoration Validation Monitoring Development	[illegible]r for [illegible]e and [illegible] fish	Relate abundance of salmonids to characteristics of stream restoration projects.	Capture methods include traps, direct observation, and electrofishing.	Capture, handle, and release	[illegible]und	[illegible] wide	[illegible]	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Steve Baumgartner, [illegible] .ca [illegible] .g	[illegible]	[illegible]diak [illegible]ion	[illegible] produ[illegible] survival	Calculate [illegible] estimate [illegible] Chinook productio[illegible] in the So[illegible]	Kodia[illegible]	[illegible]	[illegible]un	[illegible] Joaquin [illegible]ssdale	[illegible]	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	[illegible]
5	Scott Harris (707) 4[illegible] 9-2238	[illegible]	North[illegible] District and S[illegible] Resou[illegible] Assess[illegible]	[illegible] to [illegible] and [illegible]reys,	monitor [illegible] in salmonid [illegible] dan populatio[illegible]	down[illegible] and trappi[illegible] electr[illegible]	[illegible]	as needed	Eel River, Russian River, Mendocino Coastal Basins	No	No	0	0	5[illegible]	1	0	0	0	0	0	0	0	0	0	0	0	0
6	Sandy [illegible] (530) 5[illegible]	USBOR	Monitoring of Fish Entrainment at Red Bluff Research Pumping Plant	[illegible]	Monit[illegible] at RB[illegible] ment	[illegible]	[illegible]	[illegible]Sep	Sacramento River at Red Bluff	Yes	No	0	0	0	0	0	0	0	0	0	0	60	3	0	0	80	4
7	Robert Leidy (4[illegible]5 972-34[illegible]	USEPA	Distributional status and ecology of stream fishes of the San Francisco Estuary, California	Determine the distributional status and ecology of fish freshwater of [illegible] of streams [illegible] the San Francisco estuary	Studying st[illegible] ecology of status a[illegible] fish	Capture methods include electrofishing, minnow or beach seine, or dip net.	Capture, take, handle, tissues	[illegible]	S[illegible] F[illegible] E[illegible]	Yes	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	Robert Leidy (4[illegible]5) 972-3413	USEPA	Federal Clean Water Act, Section 404, Enforcement Investigations	Aquatic habitat sampling	Investigate unpermitted discharges in water bodies.	Electrofisher, minnow or beach seine, or dip net.	Capture, handle, tissues	as n[illegible]ed	as [illegible]	Yes	[illegible]	0	0	200	5	0	0	25	0	0	0	0	0	0	0	100	5
9	Phillip Barrington (707) 825-4850	CDFG	1a1: Freshwater Creek Adult Salmonid Studies	migration survey	Estimate escapement into Freshwater Creek	Permanent weir	capture/handle/tag	[illegible]	[illegible]ter	[illegible]	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	[illegible]n	CDFG	2a2: Noyo River Juvenile Steelhead and Coho Salmon Abundance	Stream surveys	Estimate juvenile abundance	electrofishing and fyke trap	capture/handle/tag	[illegible]	Noyo River	No	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project Numbo	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Funded by DFG	So. Oregon No. California Coasts coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central California coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	California Coastal Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Northern California steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
11	Phillip Barrington (707) 825-4850	CDFG	2a1 Shasta and Scott Rivers Juvenile Salmonid Abundance Estimates	migration study	Determine emigration abundance of juvenile salmonids, age and growth, evaluate restoration projects, evaluate change in migration with change in flow or water temperature	screw trap	capture [redacted] die	spring	Shasta [redacted] Scott R[redacted]	No	[redacted]	0	0	514	26	0	0	0	0	0	0	0	0	0	0	0	0
12	[redacted] p Barrington [redacted]) 825-4850	CDFG	1e2 Mad River Adult Steelhead Radio Tag Study	migration and habitat	describe habitat [redacted] and migration pattern [redacted] wild and hatchery steelhead in Mad River	seine	captu /han dle/ta	fall/winter	[redacted] liver	No	S	0	0	0	0	0	0	0	0	0	0	0	0	20	1	0	0
13	[redacted] p Barrington [redacted]) 825-4850	CDFG	2a5: Upper Redwood Creek Juvenile Steelhead Abundance Estimates	population estimates	Determine emigrant [redacted] lation estimates for [redacted] lhead and Chinook [redacted] on; and temporal [redacted] of emigration.	screw trap	[redacted] /han	spring/summer	Upper wood Redw Creek	No	S	0	0	0	0	0	0	0	0	0	0	120,713	1,093	0	0	118,543	538
14	Michael Wallace (707) 822-3702	CDFG	Juvenile Salmonid Use of Freshwater Slough, Humboldt Bay	estuarine ecology	monitor emigration patterns and determine size of emigrants	seines	captu [redacted] die/tal tissue	[redacted]	water Fresh Slough oldt Humb Bay	No	S	0	0	1,000	10	0	0	0	0	0	0	0	0	0	0	500	5
15	Michael Wallace (707) 822-3702	CDFG	Natural Stock Assessment Project: Juvenile Salmonid Emigration and Use of the Klamath River Estuary	estuarine ecology and population	Monitor juvenile coho year class strength	seines	captu [redacted] die/tal tissue	Ma - Sep	th [redacted] Estuary	£	S	0	0	100	2	0	0	0	0	0	0	0	0	0	0	0	0
16	Michael Marchetti [redacted] 898-5641	CSU Chico	Ichthyology & Aquatic Ecology Classes and Monitoring	Aquatic ecology and ichthyology class	[redacted] rate sampling [redacted] tudents at Big [redacted] d Butte Creeks.	[redacted] rofisher, seine	[redacted]	Sep S	ico Big Chico and Butte Creek	No	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	[redacted] el Johnson [redacted] 752-8837	University of California Davis	Navarro River Watershed Project	Sampling of fish in the Navarro River Estuary	To elucidate a better understanding of the significance that *estuaries play in the parr/smolt lifecycle of* steelhead in the Northern California rivers.	Capture methods include a bag seine.	Capture, handle, tissues, release	throughout the year	ro [redacted]	No	&	0	0	0	0	0	0	1	5	0	0	0	0	0	0	1,500	165
18	Michael Johnson (530) 752-8837	UC Davis	Central Valley steelhead survey - proposed	Steelhead [redacted] y on Central [redacted] tributaries	Provide information on 1) life history, 2) biological community, 3) habitat and water quality, 4) population models, 5) watershed effects assessments, 6) habitat improvement projects, 7) develop performance metrics of steelhead populations.	Snorkel, seine	Handl scale sampl	year round	Mill, pe, Antelope Yuba Deer, Feather and F	No	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Michael Fawcett (707) 876-3450	[redacted]	Long-term monitoring of juvenile salmonid abundance in Sonoma County *streams*	An ongoing study of the density of juvenile salmonids	To assess the effect of hydrologic conditions, watershed management practices, exposure to wastewater and other *factors on fish numbers*	Capture methods include seines	Capture handle [redacted] release	uly and	Russian River Salmon Creek	No	i	0	0	0	0	0	0	12	1	0	0	120	1	0	0	0	0

Project Number	Point of Con[illegible]	Affiliation	Project Title	[illegible]roject D[illegible]cription	Proj[illegible] [illegible]ec[illegible]	F[illegible]	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	Ce[illegible]l California steelhead adult non-lethal	Ce[illegible]l California steelhead adult lethal	Ce[illegible]l California steelhead ju[illegible] non-lethal	Ce[illegible]l California steelhead ju[illegible] lethal	South Central California Coast steelhead adult n[illegible] lethal	South Central California Coast steelhead adult lethal	South Central California Coast steelhead j venile non-lethal	South Central California Coast steelhead j venile lethal	Central Valley spring-run Chinook salmon adult non-lethal	Central Valley spring-run Chinook salmon adult le[illegible]	Central Valley spring-run Chinook salmon juv[illegible] non-leth[illegible]	Central Valley spring-run Chinook salmon juv[illegible] [illegible]thal	Central Valley steelhead adult non-lethal	Central Valley steelhead adult lethal	Central Valley steelhead juvenile [illegible]	Central Valley steelhead juvenile lethal
11	Phillip Barrington (707) 825-4850	CDFG	2a1 [illegible] and Scc[illegible]s Ju[illegible] [illegible]lmonid Abu[illegible] Esti[illegible]	migration survey	Determine: emigration abundance of juvenile salmonids, age and growth, evaluate restoration projects, evaluate change in migration with change in flow water temperature	screw trap	capture/handle	spring	Shasta and Scott Rivers	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Phillip Barrington (707) 825-4850	CDFG	1e2 Mad River Adult Steelhead Radio Tag Study	migratio[illegible] and hab[illegible]	describe habitat use and migratio[illegible] patterns of wild and hatchery steelhead in Mad River	[illegible]	capture/handle/tag	fall/winter	Mad River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Phillip Barrington (707) 825-4850	CDFG	2a5: Upper Redwood Creek Juvenile Steelhead A[illegible]ance Est[illegible]	population estimates	Determi[illegible]e: emigrant populati[illegible]n estimates for steelhead and Chinook salmon and temporal aspect of emigration.	screw trap	capture/handle/tag	spring/summer	Upper Redwood Creek	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Michael Wallace (707) 822-3702	CDFG	J[illegible]enile Salmonid L[illegible] of Freshwater S[illegible]h, Humboldt B[illegible]y	estuarine ecology	monitor emi[illegible]tion patterns and determine size of emigrants	seines	capture/handle/take tis[illegible]	Mar-Sept	Freshwater Slough, Humboldt Bay	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Michael Wallace (707) 822-3702	CDFG	Natural Stock Assessment Project: Juvenile Salmonid Emigration and Use of the Klamath River Estuary	estuarine e[illegible]y and popula[illegible]	Moni[illegible]r juvenile coho year cl[illegible]ss strength	seines	capture/handle/take tissues	Mar-Sept	Klamath River Estuary	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Michael Marchetti (530) 898-5641	CSU Chico	Ichthyology & Aquatic Ecology Cla[illegible] and Mo[illegible]g	Aquatic ecology and ichthyology class	[illegible] strate sampling students at Big [illegible]nd Butte Creeks.	Electrofisher, hand [illegible]ine	Ha[illegible]	Sep[illegible]	Big Chico and Butte Creeks	No	No	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0
17	Michael Johnson (530) 752-8837	Uni[illegible]sity of Cal[illegible]nia Davis	Navarro River Watershed Project	Sampling of [illegible] the Navarro [illegible] Estuary	in To elucidate a better understanding of the significance that estuaries play in the parr/smolt lifecycle of steelhead in the Northern California rivers.	Capture methods include a bag sei[illegible]	Capture, handle, take tissues, release	throughout the year	Navarro River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Michael Johnson (530) 752-8837	UC Davis	Central Valley steelhead survey - proposed	Steelhead survey in Central Valley tributaries	Provide information on 1) life history, 2) biological community, 3) habitat and water quality, 4) population models, 5) watershed effects assessments, 6) habitat improvement projects, 7) develop performance metrics of steelhead populations.	Snorkel, seine	Handle, scale sample	year round	Mill, Antelope, Deer, Yuba, and Feather	No	No	0	0	0	0	0	0	0	0	0	0	50	0	0	0	1,500	0
19	Michael Fawcett (707) 876-3450	independent consultant	Long-term monitoring of juvenile salmonid abundance in Sonoma County streams	An ongoing study of the density of juvenile salmonids	To assess the effect of hydrologic conditions, watershed management practices, exposure to wastewater and other factors on fish numbers	Capture methods include seines	Capture, handle and release	July[illegible]	Russian River, Salmon Creek	No	No	0	0	5,000	25	0	0	0	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified	So.Oregon/No. California Coasts coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central California Coast coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	California Coastal Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Northern California steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
20	Mary Greaves (530) 756-7550	Stillwater Sciences	Tuolumne River Chinook salmon (Oncorhynchus mykiss) stranding and seining surveys	Stranding surveys	Assess potential of fish stranding associated with ramping flows in the Tuolumne River.	Seine, dip net	Handle	Jan-Jun	Tuolumne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Mary Greaves (530) 756-75[illegible]	Stillwater Sciences	Tuolumne River Chinook salmon (Oncorhynchus mykiss) spawning gravel permeability assessment and monitoring program	Habitat monitoring	Measure gravel permeability and assess *juvenile distribution and* outmigration patterns in Tuolumne River and San Joaquin River.	Snorkel	Observe	Sep-Nov	Tuolumne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	[illegible] Preston [illegible] 441-5736	CDFG	North Coast California Coho Salmon Investigation	general stream surveys	Develop population indexes, identify streams for restoration, assess effectivness of restoration projects, identify streams in need of additional protection under CEQA and Fish and Game Codes.	snorkel, minnow traps, electrofishing	capture/handle	Apr-Oct and winter	396 historic coho salmon streams north of San Francisco Bay	No	No	0	0	0	0	0	0	0	0	0	0	500	15	0	0	5,000	100
23	Ken Kundargi, Ken Johnson (209) 853-2534, (209) 853-2534	CDFG	Tributary Rotary Screw Trap Operations	Distribution and abundance studies	Evaluate temporal distribution and abundance of outmigrating juvenile (fall-run) chinook salmon within San Joaquin River tributaries.	Rotary screw trap	Handle	Jan-Jun	Merced, Tuolumne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Ken Jc[illegible], Ken Kunda[illegible] eve B umg[illegible]	CDFG	Adult Salmon Genetic Evaluation	Genetic structure and adult escapement	Evaluate genetic structure and adult escapement of Chinook found in tributaries of San Joaquin River	Scale, tissue samples, hook and line, counting weirs	Handle, tissue and scale sample	Oct-Dec	Stanislaus, Tuolumne, Merced, San Joaquin tributaries	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Katie Perry (916) 445-4506	CDFG	Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout, Otolith Analysis	Life history	Examine occurrence and distribution of non/anadromous rainbow trout in the Central Valley.	Carcass and spawning surveys, electrofishing, hook and line, traps, nets	Handle	year-round; opportunistic collection of specimens	Upper Sacramento, Deer, Yuba, Mokelumne, Calaveras, Tuolumne, Feather River, Mill, [illegible], Clear [illegible], [illegible] mnes [illegible] Stanislaus River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Jose D. Setka (510) 287-2034	EBMUD Fisheries and Wildlife Division	Fisheries community monitoring program for San Leandro, San Pablo and Pinole [illegible]eks, California.	Fish comm[illegible] surveys of steelhead	Studying the fish community of steelhead	Capture methods include electrofishing and [illegible]ts.	Capture, handle, take tissues	throughout [illegible] year	San Pablo, Pinole and San Leandro Creeks	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	John Hopkirk (510) 528-0148	indepen[illegible] consult[illegible]	Continuing S[illegible]s of Native & Introduced California Non-[illegible]monid Fishes	Non-salmonid studies	Studies on non-salmonid fi[illegible]hes	Minnow seine	Observe	May-Sept	Lake Tahoe, Clear Lake	No	No	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0

Pr No	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Fed Nexus	Permitted by CDFG	CCC steelhead adult non-lethal	CCC steelhead adult lethal	CCC steelhead juvenile non-lethal	CCC steelhead juvenile lethal	South-Central California Coast steelhead adult non-lethal	South-Central California Coast steelhead adult lethal	South-Central California Coast steelhead juvenile non-lethal	South-Central California Coast steelhead juvenile lethal	Central Valley spring Chinook adult non-lethal	Central Valley spring Chinook adult lethal	Central Valley spring Chinook salmon juvenile non-lethal	Central Valley spring Chinook salmon juvenile lethal	Central Valley steelhead adult non-lethal	Central Valley steelhead adult lethal	Central Valley steelhead juvenile non-lethal	Central Valley steelhead juvenile lethal
20	[redacted] Greaves 756-7550	Stillwater Sciences	[redacted] ne River k salmon hynchus) stranding ning surveys	Stranding surveys	[redacted] otential of fish associated ding flows in the s River.	Seine, dip net	Handle	Jan-Jun	[redacted] umne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0
21	Mary Greaves (530) 756-7550	Stillwater Sciences	Tuolumne River Chinook salmon (Oncorhynchus mykiss) spawning gravel permeability assessment and monitoring program	Habitat monitoring	Measure gravel permeability and assess juvenile distribution and outmigration patterns in Tuolumne River and San Joaquin River.	S[redacted]	S[redacted] e	[redacted] S	Tuolumne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
22	[redacted] P 4 [redacted]	SS	North Coast California Coho Salmon Investigation	general st[redacted] m surveys	De[redacted] lop population inc es, identify streams for restoration, assess effectiveness of restoration Projects, identify streams in need of additional protection under CEQA and Fish and Game Codes.	snorkel, minnow traps, electrofishing	capture/handle	Apr-Oct and winter	396 historic coho salmon streams north of San Francisco Bay	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	Ken Kundargi, Ken John on (209) 853 (209) 853- S	CDFG	Tributary Rotary Screw Trap Operations	Distribu[redacted] abu d S Studie	Evaluate temporal distribution and abundance outmigrating [redacted] (fa run) chinook [redacted] within San J tributaries. [redacted]	Rotary S[redacted] trap	[redacted] e	Jan[redacted]	[redacted]d, [redacted]mne	3	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	S	S
S	K Ken Johnson, [redacted] Kundargi, Steve Baumgartner	CDFG	Adult [redacted] Geneti[redacted]	Ge ti [redacted] e n a d d [redacted]	Evaluate genetic structure and adult escapement of Chinook found in tributaries of San Joaquin River	tiss Scale, tissue sample, hook and line, counting weirs	Handle, tissue and scale sample	S-Dec	Stanislaus, Tuolumne, Merced, San Joaquin tributaries	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	300	0	0	0
25	Sie Perry (916) -S -4506	CDFG	Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout, Otolith Analysis	Life history	Examine occurrence and distribution of non/anadromous rainbow trout in the Central Valley.	Carcass and spawning surveys, electrofis[redacted] hook and[redacted] traps, net[redacted]	[redacted]	year-round; opportunistic collection of specimens	Upper Sacramento, Deer, Yuba, Mokelumne, Calaveras, Tuolumne, Feather River, Mill, Battle, Clear Creeks, Co[redacted] R [redacted] 55 R [redacted]	No	No	a	0	0	0	0	0	0	0	0	0	50	2	20	100	0	3S
26	Jose Setka (510) 8 2 34	EBMUD Fisheries and Wildlife Division	Fisheries community monitoring program ... Leandro, San Pablo and Pinole Creeks, California	Fish community survey of steelhead	S [redacted] the fish ty steelhead	Capture methods include electrofishing and nets.	Capture, take, handle, tissues	throughout the year	S Pablo, Pinole and San Leandro Creeks	No	/	0	0	[redacted]	2	0	0	0	0	0	0	0	0	0	0	0	0
27	[redacted] opkirk 528 8	independent consultant	Continuing Studies of Native & Introduced California Non-salmonid Fishes	N S Imo nid S st d S	S fi [redacted] on[redacted] alm[redacted]	[redacted]	observe	[redacted] y-S[redacted]	Lake Tahoe, Clear Lake	No	No	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. California Coasts coho salmon adult non-lethal	lethal	juvenile non-lethal	lethal	Central California Coast coho salmon adult non-lethal	lethal	juvenile non-lethal	lethal	California Coastal Chinook salmon adult non-lethal	lethal	juvenile non-lethal	lethal	Northern California steelhead adult non-lethal	lethal	juvenile non-lethal	lethal
28	Jill Andersen (530) 756-7550	Stillwater Sciences	Napa River Fisheries Monitoring Program for the US army Corps of Engineers	Monitor presence relative abundance of fish	to assess whether the Napa River/Creek restoration project is meeting its objectives in providing improved habitat for fish in the corridor	Capture method includes fyke nets, otter trawls, purse seining and beach seining	Capture, handle, and release		Napa River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Jennifer York, Shawn McBride (530) 902-2643, (916) 358-2861	CDFG	Environmental Monitoring and Assessment Program - Western Pilot Study	Stream and environmental surveys	Describe biological integrity of the locations.	Electrofish	Handle	May-Oct	90 randomly selected sites throughout California	Yes	No	0	0	0	0	0	0	1,500	30	0	0	2,000	115	0	0	5,000	250
30	Jennifer Nelson (831) 688-6768	CDFG	South Central California Coast Salmon and Steelhead Restoration and Enhancement Program	stream and estuary surveys and migration studies	Describe estuarine habitat use of salmonids, population estimates or indexes, monitoring immigration and emigration.	electrofishing, seine, fyke trap, screw trap, snorkel, telemetry	capture/handle/take tissue samples/tag	Year-round	ESU wide	No	No	0	0	0	0	0	0	125	4	0	0	0	0	0	0	0	0
31	Jeff Hagar (510) 236-7366	Hagar Environmental Science	2002-03 Salmon and steelhead survey in the San Lorenzo River system	Population analyses of fish in the San Lorenzo River	Develop baseline data for use in future trend analysis, resource management guidance, habitat protection and restoration, and fish population recovery efforts	Capture method includes electrofishing	Capture, handle and release	May-Sept	San Lorenzo River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Jeff Hagar (510) 236-7366	Hagar Environmental Science	Steelhead utilization of lower Soquel Creek	Monitor for presence and relative abundance of fish	Use knowledge of steelhead presence and habitat utilization to better inform planning decisions regarding use of creek	Capture method includes seining and electrofishing	Capture, handle and release	winter, spring, and summer	Soquel Creek	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Jeff Hagar (510) 236-7366	Hagar Environmental Science	Casa de Fruta Restoration Monitoring	Monitor for presence and relative abundance of fish	Monitor for presence and relative abundance of fish	Capture method includes electrofishing	Capture, handle and release	June/Sept-Oct	Pacheco Creek	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Jeff Hagar (510) 236-7366	Hagar Environmental Science	Arroyo Leon Steelhead Habitat Restoration	Monitor for presence and relative abundance of fish	Define the relative contributions of impoundment-reared steelhead and those reared in the more typical stream habitats in the watershed	Capture method includes electrofishing and seining	Capture, handle and release	Spring/summer	Arroyo Leon	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Jeff Hagar (510) 236-7366	Hagar Environmental Science	Carmel River Lagoon Breech Monitoring	Monitor for presence and relative abundance, distribution of fish	Monitor fish to determine how breaching of the lagoon should be undertaken to minimize adverse impacts to steelhead trout	Capture method includes seining and hoop nets	Capture, handle, take tissues, and release	Oct-May	Carmel River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Jeff Dreier	Wetlands Research Associates, Inc.	Potential fish sampling projects in small tidal channels	fish sampling in shallow tidal channels in wetland restoration sites in South San Francisco Bay	determine use of restored wetland by common fish species, including sculpins, gobies, and stickleback.	Capture methods include baited minnow traps and seine nets	Capture, handle and release	Year-round	South San Francisco Bay	No	No	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Geo	Take Activity	Time of Sampling	River System	Federal Nexus	Funded by CDFG	Central California Coast steelhead adult non-lethal		juvenile non-lethal	lethal	South Central California Coast steelhead adult non-lethal	lethal	juvenile non-lethal	lethal	Central Valley spring-run Chinook salmon adult non-lethal	lethal	juvenile non-lethal	lethal	Central Valley steelhead adult non-lethal	lethal	juvenile non-lethal	lethal
												non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal
28	Jill Andersen (530) 756-7550	Stillwater Sciences	Napa River Fisheries Monitoring Program for the US army Corps of Engineers	Monitor presence and relative abundance of fish	to assess [illegible] her the Napa River [illegible] ek restoration [illegible] ect is meeting [illegible] ctives in providing [illegible] ved habitat fo [illegible] n the corridor	Capture method includes fyke nets, ott[illegible] trawls, purse se[illegible] nd be[illegible] ning	Capture, handle, and release		Napa River	No	No	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Jenni H York, Shawn McBride (530) 902-2543, (916) 358-2861	CDFG	Environmental Monitoring and Assessment Program - Western Pilot Study	Stream and environmental surveys	Describe biological integrity of the locations.	[illegible]	Handle	[illegible]	30 randomly selected sites throu[illegible] t Calif[illegible]	Yes	No	0	0	5,000	250	0	0	200	10	0	0	500	25	0	0	1,000	70
30	[illegible]fer Nelson [illegible] 688-6768	CDFG	South Central California Coast Salmon and Steelhead Restoration and Enhancement Program	stream and estuary surveys and migration studies	Describe estuarine habitat use of salmonids, population estimates or indexes, [illegible] itoring immigration and emigration.	electrofishing, seine, fyke trap, screw trap, snorkel, telemetry	capture/handle/take tissue samples/tag	Year-round	ESU [illegible]	No	No	0	0	5,000	15	0	0	5,000	20	0	0	0	0	0	0	0	0
31	Jeff Hagar (510) 236-7366	Hagar Environmental Science	2002-03 Salmon and steelhead survey in the San Lorenzo River system	Population analyses of fi[illegible] the San Lor[illegible] River	Dev[illegible] eline data for use [illegible] ture trend analysis, resource management guidan[illegible] habitat protection and restoration, and fish population recovery efforts	Capture method includes [illegible] trofishing	Capture, handle and release	May-Sept	[illegible] orenzo	No	No	0	0	500	15	0	0	0	0	0	0	0	0	0	0	0	0
32	Jeff Hagar (510) 236-7366	Hagar Environmental Science	Steelhead utilization of lower Soquel Creek	Monitor for presence and relative abundance of fish	Use knowledge of steelhead presence and habitat utilization to better inform planning decisions regarding use of creek	Capture method includes seining and electrofishing	Capture, handle and release	winter, spring, and summer	Soquel Creek	No	No	0	0	310	9	0	0	0	0	0	0	0	0	0	0	0	0
33	Jeff Hagar (510) [illegible] 366	H[illegible] E[illegible] mental S[illegible]	Casa de Fruta Restoration Monitoring	Monitor for presence and relative abundance of fish	Monitor for p[illegible] e and relative abur[illegible] of fish	Capture method includes electrofishing	Capture, handle and release	June/Sept-Oct	Pacheco Creek	No	No	0	0	300	9	0	0	0	0	0	0	0	0	0	0	0	0
34	Jeff Hagar (510) 236-7366	H[illegible] E[illegible] nmental S[illegible]	Arroyo Leon Steelhead Habitat Restoration	Monitor for presence and relative abundance of fish	Define the relative contributions of impoundment-reared steelhead and those reared in the more typical stream habitats i the watershed	Capture method includes electrofishing and seining	Capture, handle and release	Spring/summer	Arroyo Leon	No	No	0	0	1,000	30	0	0	0	0	0	0	0	0	0	0	0	0
35	Jeff Hagar (510) 236-7366	Hagar Environmental Science	Carmel River Lagoon Breech Monitoring	Monitor for [illegible] nce nd [illegible] ve [illegible] dance, [illegible] bution of fish	Monitor fish to determ[illegible] how breaching of the lagoon should be undertaken to minimiz[illegible] adverse impacts to steelhead [illegible]	Capture method includes seining and hoop nets	Capture, handle, take tissues, and release	Oct-May	Carmel River	No	No	0	0	0	0	0	0	505	15	0	0	0	0	0	0	0	0
36	Jeff Dreier	Wetlands Research Associates, [illegible]	Potential fish sampling projects in small tidal channels	fish sampling in shallow tidal channels in wetland restoration sites in South San Francisco Bay	dete[illegible] ne use of resto[illegible] wetland [illegible] y com[illegible] ore n fish [illegible] ies, incl[illegible] g sc[illegible] [illegible] back. gob[illegible] ies and [illegible]	Capture methods include baited minnow traps and seine nets	Capture, handle and release	Year-round	South San Francisco Bay	No	No	0	0	5	0	0	0	5	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. California Coast coho adult non-lethal	So.Oregon/No. California Coast coho adult lethal	So.Oregon/No. California Coast coho juvenile non-lethal	So.Oregon/No. California Coast coho juvenile lethal	Central California Coast coho salmon adult non-lethal	Central California Coast coho salmon adult lethal	Central California Coast coho salmon juvenile non-lethal	Central California Coast coho salmon juvenile lethal	California Coastal Chinook salmon adult non-lethal	California Coastal Chinook salmon adult lethal	California Coastal Chinook salmon juvenile non-lethal	California Coastal Chinook salmon juvenile lethal	Northern California steelhead adult non-lethal	Northern California steelhead adult lethal	Northern California steelhead juvenile non-lethal	Northern California steelhead juvenile lethal
[illegible]	Jason May, Larry Brown (916) 278-3079, (916) 278-3098	USGS	USGS National Water Quality Assessment Program (NAWQA) studies in the San Joaquin River Basin	Water survey	Assess water quality using biological indicators.	Electrofisher, seining, hook and line	[illegible]	[illegible]	San Joaquin @ Vernalis, Merced, Cosumnes River	[illegible]	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	Jason May (916) 278-3079	USGS	USGS Abandoned Mine Land Investigations of Metals Contamination/Bioaccumulation (AML)	Metal contamination assessment	Characterize heavy metal bioaccumulation in organisms in watersheds associated with historical mining (e.g. Trinity River, Clear Ck).	Electro[illegible], seine, and li[illegible]	[illegible]	[illegible]-Jun	Clear [illegible]	Yes	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Jason Kindopp, Anna Kastner, Terry Mills (530) 534-2381, (530) 538-2222, (916) 227-7543	DWR, CDFG, DWR	Feather River Fish Research, Feather River Hatchery Fish Ladder Investigations	Life history	Assess survival and spawning success of spring-run Chinook in hatchery facility, and determine proportion of wild vs. hatchery adult [illegible]	Extend ladder operations	Tag, fin [illegible]	Apr-Jun	Feather River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	[illegible] Drury (916) 452-3017	CDFG	2003 Fish Species Composition Evaluation, Utilizing Electroshocking and Beach Seining, In Five Central Valley Streams	Composition, relative abundance	Document fish composition and habitat use in Bear River, Coon, Dry, Reed's and Secret Ravine Creeks.	Beach seine, electrofish	[illegible]	Year-[illegible]	Bear River, Coon, Dry, Reed's, Secret Ravine Cks	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	[illegible] Drury (916) 452 3017	CDFG	2002 Adult Spring run Chinook Salmon CVSR Trapping at Daguerre Point Dam	Population estimates and migration studies of adult spring run	Estimate population and timing/duration of upstream migration of adult spring-run above Daguerre Point Dam on Lower Yuba R during both water transfer and non-water transfer years.	Fish traps [illegible] ders	Observe, handle	[illegible]	[illegible]	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	[illegible] Drury (916) 452 3017	CDFG	2001-2002 Yuba River Rotary Screw Trap [illegible] Calibration Tes[illegible]	Population estimates and migration studies of juvenile salmonids	Estimate juvenile chinook salmon and steelhead abundance, passage (catch/effort), and condition (health index) in Lower Yuba River. Provide information on timing of emergence & migration, migration duration, and steelhead smolting index.	Rotary screw trap, beach seine, fyke net	Capture, handle, anaesthesize, release	[illegible]	Yuba River	No	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	[illegible] Drury (916) 452 3017	CDFG	2003-2006 – Yuba River Salmonid Life History Evaluation Utilizing Rotary Screw Trapping and Coded-wire Tagging	[illegible]	(1) compare the overall contribution of different juvenile Chinook salmon life history strategies to adult escapement; (2) identify juvenile Chinook salmon emigration timing, and estimate abundance; (3) estimate juvenile steelhead relative abundance; [illegible]	Ro[illegible] tra[illegible]	[illegible], tag, [illegible]rk	[illegible]-Ju	Yuba River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Protocol	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	South Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley spring-run Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
[illegible]	Jason May, Bro[illegible] (9[illegible] 3079, (916) [illegible] 3098	[illegible]	USGS National Water Quality Assessment Program (NAWQA) studies in the San Joaquin River Basin	[illegible] quality survey	Assess water [illegible] using biological indicators.	Electro[illegible] seining, hook and line	[illegible]	[illegible]	San Joaquin @ Vernalis, Merced, Cosumnes River	Yes	No	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	5
38	Jason May (916) 278-3079	U[illegible]	USGS Abandoned Mine Land Investigations of Metals Contamination/Bioaccumulation (AML)	Metal contamination assessment	Characterize [illegible] bioaccumulation [illegible] metal [illegible] organisms in [illegible] associated with [illegible] mining (e.g. Trinity R[illegible] Clear Ck).	Electrofisher, seine, hook and line	[illegible]	May[illegible]	[illegible]	Yes	No	0	0	0	0	0	0	0	0	0	1	5	3	0	1	5	5
39	Kin[illegible], Jason Kastlopp, Anna K[illegible]er, Terry Mill[illegible] (530) 534-2381, (530) 538-2222, (916) 227-7543	[illegible] CDFG, [illegible]	Feather River Fisheries Research - Feather River Hatchery Fish Ladder Investigations	[illegible] history	Assess survival and spawning success of spring-run Chinook in hatchery facility and determine proportion of wild vs. hatchery adult steelhead.	[illegible] ladder [illegible]	Tag, fin [illegible]	Apr-Jun	[illegible] River	No	No	0	0	0	0	0	0	0	0	500	[illegible]	0	0	100	2	0	0
40	Ian Drury (916) 452-3317	[illegible]	2003 Fish Species Composition Evaluation, Utilizing Electro-shocking and Beach Seining in Five Central Valley Streams	Composition and relative abundance	Document fish composition and habitat use in Bear R[illegible] Co[illegible]n, Dry, Reed's and [illegible] Ravine Creeks	[illegible] seine, [illegible] fish	[illegible]	Year[illegible]	[illegible]	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	145	3
41	Ian [illegible]ry 452[illegible] 17	CDFG	2002 Adult Spring-run Chinook Salmon (CVS[illegible]) Trapping at Daguerre Point Dam	Population estimates and migration study of adult spring-run	Estimate population timing/duration of upstream migration of adult spring-run above Daguerre Point Dam on Lower Yuba R during both water transfer and non-water transfer years.	Fish trap on ladders	Ob[illegible] han[illegible]	Ja[illegible]	[illegible] River	[illegible]	Yes	0	0	0	0	0	0	0	0	100	[illegible]	0	0	50	15	0	0
42	Ian Dru[illegible] 4[illegible]2-30	CDFG	2001-2002 Yuba River Rotary Screw Trap(s) Calibration Tests with [illegible]	Population estimates and migration study of juvenile salmonids	Estimate juvenile chinook salmon and steelhead abundance, passage (catch/effort) and condition (health index) in Lower Yuba River. Provide information on timing of emergence & migration, migration duration, and steelhead smolting index.	Rotary screw trap, beach seine, fyke net	Capture, handle, anesthesize, release	Jan-Dec	Yuba River	No	No	0	0	0	0	0	0	0	0	0	0	25000	750	0	0	7,500	[illegible]
43	Ian Dru[illegible] 452 3[illegible]	CDFG	2003-2006 [illegible] Yuba River Salmonid Life History Evaluation Utilizing Rotary Screw Trapping and Coded-wire Tagging	Life history	(1) compare the overall contribution of different juvenile Chinook salmon life history strategies to adult escapements (2) identify juvenile Chinook salmon emigration timing, and estimate abundance; (3) estimate juvenile steelhead relative abundance.	Rotary screw trap	Handle, tag, dye mark	Oct-Jun	Yuba River	No	No	0	0	0	0	0	0	0	0	0	0	11000	330	0	0	1,000	0

Permit Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	[illegible]	Take Activity	[illegible]	Site	Federal Nexus	Modified by CDFG	So.Oregon/N [illegible] coho salmon adult non-lethal	lethal	California Coastal coho salmon juvenile non-lethal	lethal	Central California Coast coho salmon adult non-lethal	lethal	juvenile non-lethal	lethal	California Coastal chinook salmon adult non-lethal	lethal	juvenile non-lethal	lethal	Northern California steelhead adult non-lethal	lethal	juvenile non-lethal	lethal
4[illegible]	[illegible] 03-30[illegible] 3	Eel River Salmon Restor[illegible] Project	[illegible]	Monitor status of salmonids in the Eel River using a downstream trap	Track population trends, spawning success, genetic population analysis, and gather data on size of steelhead on downstream smolt migration	Capture methods includes a live box McBane modified pipe trap	Capture, handle, tissues, release	[illegible]	Eel River	No	[illegible]	0	0	0	0	0	0	0	0	0	0	10,[illegible]	200	10	0	[illegible]	4[illegible]
[illegible]	Greg[illegible]ry Andrew (415) [illegible]45-1191	Marin Municipal Water District	Aquatic Resources Monitoring Workplan for Lagunitas Creek Drainage, Marin County, California	[illegible] for salmonid [illegible]dance and [illegible] at conditions	Conduct fish stud[illegible] which will provide analysis of populat[illegible] trends and provid[illegible] indicators of the [illegible]tion[illegible] health of the aqu[illegible] environment	Capture methods include electrofishing	Capture, handle and release	S[illegible]-Oct	Lagunitas Creek	No	No	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	0	0	0
[illegible]	Gary Flosi, B[illegible] Collins, Scott Downie, Steve Cannata, Cynthia LeDoux-Bloom (707) 725-1072, (707) 725-1068, (707) 725-1070, (707) 725-1015, (707) 964-1346	[illegible]	North Coast Watershed Improvement Center (NWIC) Coastal Watershed Restoration Program North Coast Watershed Assessment	1) Habitat Inventory, 2) Biological Inventory, 3) Project Planning, 4) Project monitoring and evaluation, and 5) Long term monitoring and evaluation.	Survey salmonid [illegible] population and ha[illegible]	electrofishing spawner survey	ca[illegible]ure/handle	year round	[illegible]	N[illegible]	No	0	0	0	0	0	0	2,700	1	0	0	[illegible]	[illegible]	0	0	25,000	3[illegible]
47	Gary [illegible]. Peterson (707) 629-3433	[illegible]	Program River Mattole River Juvenile Salmonid Outmigration Monitoring	Monitor down-migration and relative abundance of fish using downstream migrant trapping	monitor down[illegible] and relative a[illegible]own[illegible] of fish using [illegible]ing migrant trapp[illegible]	capture method include downstream migrant trap[illegible]	Capture, handle, tissues, release	Apr-Ju[illegible]	Mattole River, Bear Ck	N[illegible]	No	0	0	400	0	0	0	[illegible]	0	0	0	[illegible]	16	0	0	50,000	16
[illegible]	Gail [illegible]eym[illegible]u (707) 944-[illegible]5[illegible] 0	[illegible]	North B[illegible] Resto[illegible] Progr[illegible]	Habitat classification and monitoring.	Develop and [illegible] a salmon and [illegible] restoration p[illegible]	spawn[illegible] redd, c[illegible] survey[illegible] electro[illegible]	cap[illegible] dle	[illegible] round	Sonoma Creek, Petaluma river, Salmon Creek (Sonoma Co.), Walker Creek, Redwood Creek, Lagunitas Creek, Pine Gulch Creek (Marin Co.), Napa River (Napa County)	N[illegible]	No	0	0	0	0	0	0	[illegible]	6	0	0	0	0	0	0	0	0
[illegible]	Erik Cleugh [illegible]	[illegible]	South San Francisco Bay Restoration Program	Habitat classification monitoring.	Develop and imp[illegible] a salmon and ste[illegible] restoration progr[illegible]	spawn[illegible] redd, c[illegible] survey[illegible] electro[illegible] shin[illegible]	cap[illegible] dle	year round	Pinole, Marsh, Walnut Creek, Alhambra, Alameda, San Leandro, Coyote, San Francisquito San Mateo, Cordilleras, [illegible] d/or Pajaro	N[illegible]	No	0	0	0	0	0	0	[illegible]	5	0	0	0	0	0	0	0	0

Proj Num	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Permits	Modified by CDFG	Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	South Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley spring-run Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
44	Harry Vaughn (707) 943-3233	Eel River Salmon Restoration Project	Eel River salmon restoration p	Monitor status of salmonids in the Eel River using a downstream migrant trap	Track population trends, spawning success, genetic population analysis, and gather s on size of steelhead downstream smolt migration	Capture method includes a live box McBane modified pipe trap	Capture, handle, take tissue and release	Spring	Eel River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Gregory Andrew (415) 945-1191	Municipal District	Aquatic Resources Monitoring Workplan for Lagunitas Creek Drainage, Marin County, California	Monitor salmonid abundance and habitat conditions	Conduct fish studies which will provide an analysis of population trends and provide indicators of the general health of the aquatic environment	Capture methods include electrofishing	Capture, handle and release	Sep-Oct	Lagunitas Creek	No	No	0	0	3,000	100	0	0	0	0	0	0	0	0	0	0	0	0
46	Gary Flosi, Barry Collins, Scott Downie, Steve Cannata, Cynthia LeDoux-Bloom (707) 725-1072, (707) 725-1088, (707) 725-1070, (707) 725-1015, (707) 964-1346	CDFG	North Coast Watershed Improvement Center (NWWIC), Coastal Watershed Restoration Program, North Coast Watershed Assessment Program	1) Habitat inventory, 2) Biological inventory, 3) Project Planning, 4) Project monitoring and evaluation, and 5) Long term monitoring and evaluation.	Survey salmonid population and habitats	fis spawner survey	re/han	round	ESU wide	No	No	0	0	8,000	90	0	0	2,500	15	0	0	0	0	0	0	0	0
47	Gary D. Peterson (707) 629-3433	Mattole Salmon Group	Mattole River juvenile salmonid outmigrant monitoring	monitor down-migration and relative abundance of fish using downstream migrant trapping	monitor down migration and relative abundance of fish using downstream migrant trapping	capture methods include downstream migrant traps	Capture, handle, take tissues, release	Apr-Jul	Mattole River, Bear Ck	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	Gail Seymour (707) 944-5570	CDFG	North Bay Restoration Program	Habitat classification and monitoring.	Develop and implement a salmon and steelhead restoration program	spawning, redd, carcass surveys, electrofishing	capture/handle	year round	Sonoma Creek, Petaluma river, Salmon Creek (Sonoma Co.), Walker Creek, Redwood Creek, Lagunitas Creek, Pine Gulch Creek (Marin Co.), Napa River (Napa County)	No	No	0	0	1,200	12	0	0	0	0	0	0	0	0	.0	0	0	0
49	Erika Cleugh ecleugh@dfg.ca.gov	CDFG	South San Francisco Bay Restoration Program	Habitat classification and monitoring.	Develop and implement a salmon and steelhead restoration program	spawning, redd, carcass surveys, electrofishing	capture/handle	year round	Pinole, Marsh, Walnut Creek, Alhambra, Alameda, San Leandro, Coyote, San Francisquito, San Mateo, Cordilleras, and/or Pajaro	No	No	0	0	1,000	50	0	0	0	0	0	0	0	0	0	0	0	0

[illegible]	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. California Coasts coho salmon				Central California Coast coho salmon				California Coastal Chinook salmon				Northern California steelhead			
												adult		juvenile		adult		juvenile		adult		juvenile		adult		juvenile	
												non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal	non-lethal	lethal
50	Douglas Rischbieter (209) 795-7105	Dep[redacted] t of Park [redacted] Recr[redacted]	Aquatic Resource Inventory and Monitoring, California State Parks	Monitoring status of fish	monitor status of fish so that State Parks can manage for their protection and enhancement	Capture methods include electrofishing, seining, and dip-netting	Capture, handle and release	as needed	as needed	No	No	0	0	0	0	0	0	25	0	0	0	10	0	0	0	40	0
51	Douglas Killam (530) 527-8892	CDFG	Sport Fish Restoration Act - Project 35: Sacramento River Salmon and Steelhead Assessment - Job 1. Sacramento River Adult Salmon and Steelhead Counts and Spawning Stock Survey	Spawner abundance	Determine annual spawner abundance of winter-run, spring-run and fall-run upstream in Sac R upstream of Feather R confluence.	Ladder counts, carcass, snorkel and aerial redd surveys	Handle	[redacted] p	Sacramento River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	Doug Albin (707) 964-7683	CDFG	Mendocino-Northern Sonoma Coastal Watersheds Salmonid Restoration Proj.	Habitat classification and monitoring.	I[redacted] ntory of [redacted] habitat and species [redacted] Prioritize rest[redacted]n sites.	spawning surveys, electrofishing	capture/handle	year round	streams entering the Pacific Ocean [redacted] of the Mendocino-Humboldt county line and north of the Russian River	No	No	0	0	0	0	0	0	100	1	0	0	10	1	0	0	500	5
53	[redacted] Pedersen [redacted]) 822-9607	[redacted] water [redacted] ences	Napa River and Sonoma Creek [redacted] ersheds [illegible] mod to limiting [illegible] tory Studies	Steelhead growth will be measured under a series of potential management options	To help guide management strategies to promote recovery of steelhead within the Napa River and Sonoma Creek basins	Capture method includes pole seining and electrofishing, drift netting. Fish will also be given a unique subcutaneous mark.	Capture, handle, mark fish, and release		Napa River and Sonoma Creek	No		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Diane Coulon (530) 865-9331	CDFG	Sacramento River Juvenile Salmonid Emigration Monitoring at the Glenn-Colusa Irrigation District (GCID) Hamilton City Pumping Plant Fish Screen (HCPP)	Life history	Obtain life history information on emigrating juvenile chinook salmon in the Upper Sacramento R, specifically monitoring winter-run passing through HCPP bypass channel. (A real time monitoring site.)	Rotary screw trap	Trap, handle	Year-round	upper Sacramento River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Dennis Blakeman (209) 853-2500	CDFG	Restoration Project Monitoring	Biological data to evaluate restoration project	Collect steelhead data during pre- and post-restoration activities	Fyke nets, beach seines, backpack electrofisher, angling, snorkeling, surveying rods/transits.	Handle	Mar-Aug	Merced, Tuolumne, Mokelumne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Des[redacted]	Project Objective	P	Take Activity	Time of Sample	River System	Federal Nexus	Modified by CDFG	Central California Coast steelhead adult non-lethal	Central California Coast steelhead adult lethal	Central California Coast steelhead juvenile non-lethal	Central California Coast steelhead juvenile lethal	South Central California Coast steelhead adult non-lethal	South Central California Coast steelhead adult lethal	South Central California Coast steelhead juvenile non-lethal	South Central California Coast steelhead juvenile lethal	Central Valley spring-run Chinook salmon adult non-lethal	Central Valley spring-run Chinook salmon adult lethal	Central Valley spring-run Chinook salmon juvenile non-lethal	Central Valley spring-run Chinook salmon juvenile lethal	Central Valley steelhead adult non-lethal	Central Valley steelhead adult lethal	Central Valley steelhead juvenile non-lethal	Central Valley steelhead juvenile lethal
50	Douglas Rischbieter (209) 795-7105	Department of Parks and Recreation	Aquatic Resource Inventory and Monitoring, California State Parks	Monitoring status of fish	monitor status of fish so that State Parks can manage for their protection and enhancement	Capture methods include electrofishing, seining, and dip-netting	Capture, handle and release	as needed	as needed	No	No	0	0	40	0	0	0	40	0	0	0	0	0	0	0	0	0
51	Douglas Killam (530) 527-8892	CDFG	Sp Re Project: Sacramento River Salmon and Steelhead Assessment - Job 1. Sacramento River Adult Salmon and Steelhead Counts and Spawning Stock Survey	Spawner abundance	Determine annual spawner abundance of winter-run, spring-run and fall-run upstream in Sac R upstream of Feather R confluence.	Ladder counts, carcass, snorkel and aerial redd surveys	Handle	May-Sep	mento	No	No	0	0	0	0	0	0	0	0	4,000	0	0	0	4,000	0	0	0
52	Doug Albin (707) 964-7683	CDFG	Mendocino-Northern Sonoma Coastal Watersheds Salmonid Restoration Proj.	Habitat classification monitoring.	ntory of fish habitat species and itize restoration s.	spawning surveys, electrofishing	capture/handle	year round	streams entering the Pacific Ocean south of the Mendocino-Humboldt county line and north of the Russian River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	Dirk Pedersen (707) 822-9607	Stillwater Sciences	Napa River and Sonoma Creek watersheds salmonid limiting factors studies	Steelhead growth will be measured under a series of potential management options	To help guid managemen strategies to promote r covery of steelhead within the Napa River and Sonoma Creek basins	Capture method includes pole seining and electrofishing, drift netting. Fish will also be given a unique subcutaneous mark.	Capture, handle, mark fish, and release		Napa River and Sonoma Creek	No		0	0	2,200	35	0	0	0	0	0	0	0	0	0	0	0	0
54	Diane Coulon (530) 865-9331	CDFG	Sacramento River Juvenile Salmonid Emigration Monitoring at the Glenn-Colusa Irrigation District (GCID) Hamilton City Pumping Plant Fish Screen (HCPP)	Life history	Obtain life history information on emigrating juvenile chinook salmon in the Upper Sacramento R, specifically monitoring winter-run passing through HCPP bypass channel. (A real time monitoring site.)	Rotary screw trap	Trap, handle	Year-round	upper Sacramento River	No	No	0	0	0	0	0	0	0	0	0	0	2,287	32	0	0	635	9
55	Dennis Blakeman (209) 853-2533	CDFG	Restoration Project Monitoring	Biological data to evaluate restoration project	Collect steelhead data during pre- and post-restoration activities	Fyke nets, beach seines, backpack electrofisher, angling, snorkeling, surveying rods/transits.	Handle	Mar-Aug	Merced, Tuolumne, Mokelumne	No	No	0	0	0	0	0	0	0	0	0	0	0	0	50	0	50	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	[redacted] of [redacted]ing	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. California Coasts coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central California coast coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	California Coastal Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Northern California steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
56	Dean Marston	CDFG	Adult Steelhead Monitoring Program	Life history and habitat use	Document presence, origin, migration timing, distribution, abundance, habitat utilization, environmental factors influencing adult steelhead in San Joaquin Basin	Hook and line, backpack electrofisher, snorkel, counting weirs, beach seines, fish traps, may include drift boats, jet boats.	Measure fish, take scale and fin samples, survey spawning habitat and redds.	Jun-Apr	Stanislaus, Toulumne, Merced, Main stem San Joaquin River	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	Dean Mars[redacted] (559) 243-[redacted]	CDFG	Juvenile Salmonid Abundance/ Distribution Project	Population and habitat studies	Document presence, habitat use, and abundance of fall-run Chinook salmon and steelhead rainbow trout within the San Joaquin River basin, and environmental variables.	Fyke nets, snorkel, hook and line, beach seines, backpack electrofisher.	Handle, fin and scale samples	Ma[redacted]	Stanislaus, Tuolumne, Merced, Main stem San Joaquin River	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	David Salsbery (408) 265-2607 ext 2713	Santa Clara Valley Water District	Santa Clara County Water District Aquatic Resources Management Program	Monitoring distribution relative abundance steelhead.	Monitoring distribution and relative abundance of steelhead.	Capture methods include electrofishing, nets, traps, seines. Radio telemetry and PIT tags will be used.	Capture, handle, tag, take tissues	[redacted]round	Guadalupe River, Coyote Creek, and Stevens Creek	No		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	David Fuller (707) 825-2315	Bureau of Land Management	BLM Arcata Field Office fish and water quality monitoring	Monitor for presence and abundance of fish and detect trends in water quality attributes by conducting aquatic macroinvertebrates surveys	Monitor for abundance and presence of fish and water quality	Capture methods include electrofishing	Capture, handle and release		Mattole River, South Fork Elk River, Van Duzen River, Eel River, and coastal drainages on the west side of the King Range National Conservation Area.	Yes	No	0	0	0	0	0	0	55	0	0	0	55	0	0	0	110	0
60	Dale Gates (209) 853-9136	CDFO	[redacted] Ferry Barrier [redacted]ration	Impede fish passage to unsuitable habitat	Block upstream migration of adult Chinook salmon on San Joaquin River above confluence of Merced River because lack of suitable spawning habitat.	Weir	Trap, handle, tag	Sept	San Joaquin @ Merced R	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	[illegible]	[illegible]	Modified by CDFG	California Coastal steelhead adult non-lethal	California Coastal steelhead adult lethal	California Coastal steelhead juvenile non-lethal	California Coastal steelhead juvenile lethal	South Central California Coast steelhead adult non-lethal	South Central California Coast steelhead adult lethal	South Central California Coast steelhead juvenile non-lethal	South Central California Coast steelhead juvenile lethal	Central Valley spring-run Chinook salmon adult non-lethal	Central Valley spring-run Chinook salmon adult lethal	Central Valley spring-run Chinook salmon juvenile non-lethal	Central Valley spring-run Chinook salmon juvenile lethal	Central Valley steelhead adult non-lethal	Central Valley steelhead adult lethal	Central Valley steelhead juvenile non-lethal	Central Valley steelhead juvenile lethal
56	Dean Marston	CDFG	Adult Steelhead Monitoring Program	Life history and habitat use	Document presence, origin, migration timing, distribution, abundance, habitat utilization, environmental factors influencing adult steelhead in San Joaquin Basin	Hook and line, backpack electrofisher, snorkel, counting weirs, beach seines, fish traps, may include drift boats, jet boats.	Measure fish, take scale and fin samples, survey spawning habitats and redds.	Jun-Apr	Stanislaus, Toulumne, Merced, Main stem San Joaquin River	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1,000	0	0	0
57	Dean Marston (559) 243-4017	CDFG	Juvenile Salmonid Abundance/ Distribution Project	Population [illegible] habitat stu[illegible]	Document presence, habitat use, and abundance of fall-run Chinook salmon and steelhead rainbow trout within the San Joaquin River basin, and environmental variables.	Fyke nets, snorkel, hook and line, beach seines, backp[illegible] electrofisher.	[illegible]	Mar-Jul	Stanislaus, Tuolumne, Merced, Main stem San Joaquin River	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,000	0
58	David Salsbery (408) 265-2607 ext 2713	Santa Clara Valley Water District	Santa Clara [illegible] Water [illegible] Aquatic [illegible] [illegible]agement [illegible]gram	Monitoring distribution and relative abundance of steelhead.	[illegible] distribution [illegible] abundance [illegible]ead.	Capture methods include electrofishing, nets, traps, [illegible]s. Radio telemetry and PIT tags will be used.	Capture, handle, tag, take tissues	year round	Guadalupe River, Coyote Creek, and Stevens Creek	No		75	0	1,100	33	0	0	0	0	0	0	0	0	0	0	0	0
59	David Fuller (707) 825-2315	Bureau of Land Management	BLM Arcata Field Office fish and water quality monitoring	Monitor for presence and abundance of fish and detect trends in water quality attributes by conducting aquatic macroinvertebrates surveys	Monitor for abundance and presence of fish and water quality	Capture methods include electrofishing	Capture, handle and release		Mattole River, South Fork Elk River, Van Duzen River, Eel River, and coastal drainages on the west side of the King Range National Conservation Area.	Yes	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	Dale Gates (209) 853-9136	CDFG	Hills Ferry Barrier Operation	Impede fish passage to unsuitable habitat	Block upstream migration of adult Chinook salmon on San Joaquin River above confluence of Merced River because lack of suitable spawning habitat.	Weir	[illegible] tag	[illegible]	San Joaquin @ Merced R	No	No	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0

Project Number	Project Contact	Lead	Title	Project Description	Project Objective	Project Gear	Take Activity	Timing of Sampling	River System	Federal Nexus	Modified by CDFG	California Coastal salmon adult non-lethal	California Coastal salmon adult lethal	California Coastal salmon juvenile non-lethal	California Coastal salmon juvenile lethal	Central California coho salmon adult non-lethal	Central California coho salmon adult lethal	Coast juvenile non-lethal	Coast juvenile lethal	Coastal adult non-lethal	Coastal adult lethal	Coastal juvenile non-lethal	Coastal juvenile lethal	Northern California steelhead adult non-lethal	Northern California steelhead adult lethal	Northern California steelhead juvenile non-lethal	Northern California steelhead juvenile lethal
61	Colleen Harvey Arrison (530) 527-8892	CDFG	Sport Fish Restoration Act - Project 35: Sacramento River Salmon and Steelhead Assessment - Job 2. Spring-run Chinook Salmon Life History Investigations in Mill and Deer Creeks, Tehama County.	[illegible] history	Predict spring-run Chinook salmon occurrence in the Delta on a real time basis. Monitor adult and juvenile life history.	Backpack electrofisher, rotary screw trap, beach seine, snorkel surveys	[illegible]	[illegible]	Mill, Deer, Antelope, Cottonwood Cks	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	Brian [illegible] 862-[illegible]	San Francisco Public Utilities Commission	Alameda Creek Trout Restoration	This project will evaluate how stream flows affect stream habitat conditions and how this influences the fish population present in the Creek	Monitor fish populations to determine whether goals of restoring flows to creek are helping restore fish populations	Capture methods include electrofishing, trapping, and hook and line	Capture, handle, tissues, release	year [illegible]	Alameda Creek	S	No	0	0	0	0	0	0	0	0	0	0	0	0	a	0	0	0
63	Bob Coey, Derek Acomb (707) 744-8704, (707) 744-8703	DFG	Russian River Restoration Program	Habitat classification and monitoring.	[illegible] fish habitats	electrofishing	capture, handle	year round	Russian River	£	No	0	0	0	0	0	0	500	6	0	0	20	0	0	0	0	0
64	Bill S[illegible], Rob Titus [illegible] 6336, 6390	DFG	Central Valley Salmon and Steelhead Life-History Assessments: Use of Scales and Otoliths	Scale and otolith	Use scales and otolith to provide information on: 1) stock identification of various origins (wild vs. hatchery, basin, stream, etc.); 2) juvenile residence time in system 3) age structure of adults in Central Valley; 4) relative contribution of hatcher	Opportunistic sampling from existing activities & carca	[illegible]	opportunistic collection of specimens	Coleman, Feather, Nimbus, Mokelumne R hatc	£	J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	Bill Snider, Rob Titus (916) 227-6336 (916) 227-6390	DFG	Upper Sacramento River Stream Flow and Habitat Study	Spawning, rearing, and abundance studies	Determine timing and distribution of steelhead spawning and rearing in Upper Sacramento R. as a function of stream flow and habitat. Provide presence/absence and relative abundance of different life-stages of steelhead.	Sein	Hi! s)	1	[illegible]	No	£	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	Bill Snider, Rob Titus (916) 227-6336 (916) 227-6390	DFG	Lower Rector Creek/Conn Creek/Napa River Steelhead Habitat Study	Life history, habitat use	Determine the use of creek by steelhead; and identify factors limiting use.	Direct observation and electrofishing	Capture, handle, anaesthesize, release or intentional mortality	[illegible]	Lower Creek Creek River Steelhead Habitat	No	£	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
&	Bill Snider, Rob Titus (916) 227-6336, (916) 227-6390	DFG	If	Spawning, rearing, and abundance studies	Determine juvenile abundance, timing and distribution of steelhead spawning and rearing.	Seine, backpack electrofishing, PIT tagging, scale s	Handle, scale sampl	Nov	American R	No	i	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pr Nu	[redacted] t of [redacted] act	[redacted] liation	Project Title	P [redacted]	P [redacted] Objective	[redacted] ect [redacted] ar	Take Activity	T [redacted] of Sa [redacted] ling	River System	[redacted] N	Modified by CDFG	Central California Coast steelhead adult [redacted]	[redacted] al	juvenile [redacted]	le [redacted]	South-Central California Coast steelhead adult non-let	lethal	juvenile non-lethal	lethal	Central Valley spring-run Chinook salmon adult [redacted]	lethal	juvenile [redacted]	al	Central Valley steelhead adult non-lethal	lethal	juvenile non-lethal	lethal
61	[redacted] en Harvey [redacted] on (530) 527- [redacted]	CDFG	Sport Fish Restoration S Project 35: Sacramento R e Salmon and Steelhead Assessment - Job 2. Spring-run Chinook Salmon Life History Investigations in Mill and Deer Creeks, Tehama County.	Life history stu [redacted]	Pred... spring-run Chinook salmon occurr... in the Deln on a re... time basis Monit... adult and juven... history.	Backpack electrofisher, rotary screw trap, beach seine, snorkel surveys	Handle	Year-round	[redacted]	No	S	0	0	0	0	0	0	0	0	0	0	10,017	S	0	0	1,203	47
62	[redacted] Sak [redacted] 439	San Francisco Public Utilities Commission	Alameda Creek Trout Restoration	This project will evaluate how stream flows affect stream habitat conditions and how this influences the fish populations present in the Creek	Monitor fish populations to determine whether goals of restoring flows to creek are helping restore fish populations	Capture method includes electrofishing, trapping, and hook and line	Capture, handle, take tissues and release	year round	Alameda Creek	N	No	0	0	24	1	0	0	0	0	0	0	0	0	0	0	0	0
8	Bob Coey, Derak Acomb (707) 744-8704, (707) 744-8703	CDFG	Russian River Restoration Program	Habitat classification monitoring, and	[redacted]	[redacted]	capture/handle	year round	Russian River	No	No	0	0	1 200	2	0	0	0	0	0	0	0	0	0	0	0	0
S	Bill Snider, Rob Titus (916) 227-6336, (916) 227-6390	CDFG	Central Valley Salmon and Steelhead Life-History Assessments: Use of Scales and Otoliths	Scale and oto lith	Use sca... to provi... on: 1) si... of vario... vs. hatc... stream, residen... system; of adult... Valley; contribu... hs d nile ure r	Opportunistic from sampling existing activities, carcasse	Handle	[redacted] tunistic [redacted] tior [redacted] ime 0 s	Coleman, Feather, Nimbus, Mokelumne R hatcheries	N	Yes	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	400
S	Bill Snider, Rob Titus (916) 227-6336 (916) 227-6390	CDFG	Upper Sacramento River Stream Flow and Habitat Study	Spawning, rearing, and abundance studies	Determ... distribu... spawni... Upper S... a functi... and hat... presenc... relative differen... steelhe... ad a nd	[redacted]	Observe (adults) seine (juveniles)	year round	Sacramento River	N	No	0	0	0	0	0	0	0	0	0	0	10	2	0	0	50	5
S	Bill Snider, Rob Titus (916) 227-6336 (916) 227-6390	CDFG	Lower Rector Creek/Conn Creek/Napa River Steelhead Habitat Study	Life history and habitat use	Determ [redacted] creek b [redacted] ind identify [redacted] g use.	Direct observation S and electrofis [redacted]	Capture handle, anaesthesize, release or intentional mortality		Lower Rector Creek/Conn Creek/Napa River Steelhead Habitat Study	N	No	0	0	50	50	0	0	0	0	0	0	0	0	0	0	0	0
&	Bill Snider, Rob Titus (916) 227-6336 (916) 227-6390	CDFG	Lower American River Steelhead Habitat Use Monitoring	Spawning, rearing, and abundance studies	Determine juvenile abundance, timing and distribution of steelhead spawning and rearing.	Seine, backpack electrofisher, PIT tags, scales	Handle, tag, scale sample	Mar-Nov	American River	N	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,0 0	9

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. Cal. coho salmon adult non-lethal	So.Oregon/No. Cal. coho salmon adult lethal	So.Oregon/No. Cal. coho salmon juvenile non-lethal	So.Oregon/No. Cal. coho salmon juvenile lethal	Central California Coast coho salmon adult non-lethal	Central California Coast coho salmon adult lethal	Central California Coast coho salmon juvenile non-lethal	Central California Coast coho salmon juvenile lethal	California Coastal Chinook salmon adult non-lethal	California Coastal Chinook salmon adult lethal	California Coastal Chinook salmon juvenile non-lethal	California Coastal Chinook salmon juvenile lethal	Northern California steelhead adult non-lethal	Northern California steelhead adult lethal	Northern California steelhead juvenile non-lethal	Northern California steelhead juvenile lethal
68	Snider, Rob Titus (916) 227-[illegible], (916) 227-[illegible]	CDFG	Central Valley Juvenile Salmon and Steelhead Emigration Monitoring	[redacted] ation and ulation s	[redacted] population size, timing, age composition of stream migrating salmon and steelhead.	Rotary screw trap, kodiak trawl, round fyke	[redacted]	Sept-Jul	Sacramento River (Balls Ferry, Knights Landing, American R, Dry Ck) Dry Ck	[redacted]	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	Snider, Rob Titus (916) 227-[illegible], (916) 227-[illegible]	CDFG	Dry Creek Steelhead Life History and Habitat Use Study	his[redacted] and tat[redacted]	Understand steelhead use of low-elevation tributaries by monitoring steelhead spawning, rearing, growth, and emigration [redacted] ciated with habitat use and conditions in Dry Ck.	[redacted]	[redacted]	[illegible]	Dry Ck	S	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	[illegible] Cox (707 [illegible]	DFG	District Biolog[redacted]	monitoring, stream surveys, and restoration assessments Habitat use	Determine distribution and habitat use of various fish species	electrofisher, seine, dipnet	[illegible]	random sampling	random sampling	No	No	0	0	0	0	0	0	205	CM	0	0	20	1	0	0	205	2
71	Alice Seesholtz, Terry Mills (916) 227-7539, (916) 227-7543	DWR	Feath Fishe Resea Chino Study ing etry	Habitat use	Study m[illegible] holding [redacted] spring-run [illegible] Feather River.	Fyke trap, angling	[redacted]	Apr-Jul	Feather River	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SI	Gregory Fanslow (510) 848-8098 x 119 (replaced 61)	Stillwater Sciences	Recon level Steel (Onc mykis Chino (O. ts Habit and P Dyna Calav (Cala Joaqu Stanis Count	e- Reconnaissance of fish population, habitats, and flow	Provide information on chinook salmon and steelhead populations in the Calaveras River to restore self-sustaining fish populations.	beach seine, electrofisher, dip net, snorkel and spawner survey, tag, marks, tissue sample	[redacted]	Oct-Jun	[redacted] 3	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	[illegible]am Mitchell [illegible] 737-300	[illegible] Stokes	[redacted]	Assess effects potential effects of water transfer operations on steelhead and fall and spring-run Chinook salmon juveniles and habitats	Assess potential effects of water transfer operations on steelhead and fall and spring run Chinook salmon juveniles and their habitats in the lower Yuba River	Rotary screw traps	[redacted]	May-Oct	Lower Yuba River	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	[illegible]ael Marc[illegible] [illegible] 898-56[illegible]	CA State Chico	[redacted] Chico Creek Monitoring	Monitoring of non-salmonid fish in Big Chico Creek to examine effects of non-native species and hydrologic alterations on fishes.	Monitoring of non-salmonid populations and communities in Big Chico Creek once or twice annually	electrofisher, hand seine	handle	[redacted] Sept	Lower River [illegible]	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	[illegible]	Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	South Central California Coast steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley spring-run Chinook salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central Valley steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
68	Bill Snider, Rob Titus (916) 227-6336, (916) 227-6390	CDFG	Central Valley Juvenile Salmon and Steelhead Emigration Monitoring	Migration and population studies	[redacted] population from ... nce, composition stream migrating and ...	Rotary screw trap, kodiak trawl, round fyke	Trap, handle	Sept-Jul	Sacramento River (Balls Ferry, Knights Landing, American R, Dry Ck)	No	No	0	0	0	0	0	0	0	0	0	0	2,050	62	0	0	3,950	120
69	Bill Snider, Rob Titus (916) 227-6336, (916) 227-6390	CDFG	Dry Creek Steelhead Life History and Habitat Use Study	Life history and habitat use	Understand steelhead use of low-elevation tributaries by monitoring steelhead spawning, rearing, growth, and emigration associated with habitat use and conditions in Dry Ck.	Snorkel, electrofish	Handle	May-Aug	Dry Ck	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200	5
70	Bill [illegible] (707) 823-100 [illegible]	CDFG	Dist [illegible] Biol[illegible]	monitoring, stream surveys, and restoration assessments habitat use	Determine distribution and habitat use of various fish species	electrofisher, seine, dipnet	capture/handle	random sampling	[illegible]	No	No	0	0	410	4	0	0	0	0	0	0	0	0	0	0	0	0
71	Alicia Seesholtz, Terry Mills (916) 227-7539, (916) 227-7543	DWR	Feather River Fisheries Research - Spring Chinook Telemetry Study		Study [illegible] holding [illegible] spring [illegible] of Feather River.	Fyke trap, angling	Radio tags	[illegible]	Fe[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	30	1	0	0	0	0	0	0
72	Gregory Fanslow (510) 848-8098 x 119 (replaced 61)	Stillwater Sciences	Reconnaissance-level Evaluation of Steelhead (Oncorhynchus mykiss) and Chinook Salmon (O. tshawytscha) Habitat Conditions and Population Dynamics in the Calaveras River (Calaveras, San Joaquin and Stanislaus Counties, CA)	Reconnaissance of fish populations, habitats, and flows	Provide information on chinook salmon and steelhead populations in the Calaveras River to restore self-sustaining fish populations.	Beach seine, electrofisher, dip net, snorkel and spawner surveys, tag, marks, tissue sample	Capture, handle, tag, take tissues	Oct-Jun	Calaveras	No	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	700	10
73	William Mitchell (916) 737-3000	Jones & Stokes	2003 Yuba River Water Transfer Monitoring and Evaluation Program	*Assess potential effects of water transfer operations on steelhead and Chinook salmon juveniles and habitats*	*Assess potential effects of water transfer operations on steelhead and fall and spring-run Chinook salmon juveniles and their habitats in the lower Yuba River*	*Rotary screw traps*	*handle, mark*	May-Oct	Lower Yuba River	No	Yes	0	0	0	0	0	0	0	0	0	0	15,000	300	0	0	13,000	260
74	Michael Marchetti (530) 898-5641	Cal State Chico	Big Chico Creek Monitoring	Monitoring of non-salmonid fish in Big Chico Creek to examine effects of non-native species and hydrologic alterations on fishes.	Monitoring of non-salmonid populations and communities in Big Chico Creek once or twice annually	electrofisher, hand seine	handle	Aug-Sept	Big Chico Creek	No	Yes	0	0	0	0	0	0	0	0	0	0	10	1	0	0	20	1

Proj Num	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project Gear	Take Activity	Time of Sampling	River System	Federal Nexus	Modified by CDFG	So.Oregon/No. California Coasts coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Central California Coast coho salmon adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	California Coastal Chinook adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal	Northern California steelhead adult non-lethal	adult lethal	juvenile non-lethal	juvenile lethal
[illegible]	Tedd Sedell (541) 750-7069 and Chris Moyer (541) 750-7017	USDA F[redacted] Service [redacted] BLM	Aquatic and Riparian Effectiveness Monitoring Program for the Northwest Forest Plan	Biological and habitat monitoring of federal lands in Northwest Forest P[illegible]	Assess condition of watersheds	electrofisher	h[redacted]	J[illegible]	[redacted] Slide [redacted] E.F. [redacted] Creek, [redacted] Valley Creek, Horse Linto Creek, Fall Creek, Lower Scotts Creek, Lower Squaw Creek, South Tule Lake Sump Stony Creek, Little Trinity River Upper Blue Creek	[illegible]	Yes	0	0			0	0	100	5	0	0	100	5	0	0	50	25
76	O[illegible] [redacted] nslow (51 [redacted] 098 x 119	Stillwater Sciences	Assessment of Factors Potentially Limiting Steelhead (Oncorhynchus mykiss) Population Abundance in Stevens Creek S[illegible] Clara C[illegible] CA)	Life history and habitat use	Determine limiting factors to success of steelhead population. May include habitat surveys, fish census and life history studies.	may include: beach seine, electrofisher, traps, snorkel and spawner surveys, tags	handl[illegible] [redacted] k[illegible] ey	Y[redacted] ro [redacted]	S[illegible]	No	[redacted]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	Paul Ward (530) 895-5[illegible]5, Tracy McReynolds (530) 895-5111	CDFG	Butte and Big Chico Creeks Spring-Run Chinook Salmon Life History Investigation	life history	Monitor and tag juvenile spring-run salmon and estimate adult escapement in Butte and Big [redacted] [redacted] s	[redacted] ry screw traps, snorkel	handle, mark, carcass survey	Y[redacted] round	Butte and Big Chico creek	No	No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[illegible]	Phillip Barrington (707) 825-4850	CDFG	2a[illegible]: Freshwater Creek juvenile salmonid abundance estimates	Population estimates	Estimate [redacted] ation of juvenile [redacted] ids	out migrant traps	ha[illegible]	Yea[illegible] [redacted]	F[illegible] Cre[illegible]	No	No			201,1[illegible]	[illegible]							20,812	[illegible]			[illegible]	11

Project Number	Point of Contact	Affiliation	Project Title	Project Description	Project Objective	Project [redacted]	Take Activity	Time of Sampling	River System	Federal Nexus	Modified CDFG	Central California Coast steelhead				South Central California Coast steelhead				Central Valley spring-run Chinook salmon				Ce Valley ead			
												adult		juvenile		adult		juvenile		adult		juvenile		adult		juvenile	
												non-lethal	lethal	[redacted]	[redacted]	non-lethal	lethal	non-lethal	lethal	[redacted]	lethal	non-lethal	lethal	non-lethal	let	non-lethal	lethal
75	Tedd Sedell (541) 750-7069 and Chris Moyer (541) 750-7017	USDA Forest Service and BLM	Aquatic and Riparian Effectiveness Monitoring Program for the Northwest Forest Plan	Biological and habitat monitoring of federal lands in Northwest Forest Plan.	Assess condition of watersheds	electrofisher	handle	Jun-Sept	Blue Slide Creek, E.F. Indian Creek, Indian Valley Creek, Horse Linto Creek, Fall Creek, Lower Scotts Creek, Lower Squaw Creek, South Tule Lake Sump, Stoney Creek, Little Trinity River Upper Blue Creek	Yes	Yes	0	0	250	12	0	0	0	0	0	0	100	5	0	0	0	0
76	Gregory Fanslow (510) 848-8098 x 119	Stillwater Sciences	Assessment of Factors Potentially Limiting Steelhead (Oncorhynchus mykiss) Population Abundance in Steven's Creek (Santa Clara County CA)	[redacted] and	Determine limiting factors to success of steelhead population. May include habitat surveys, fish census and life history studies.	may include: beach seine, electrofisher, traps, snorkel and spawner surveys, tags	handle, mark, survey	Year-round	Steven's Creek	No	No	0	0	350	5	0	0	0	0	0	0	0	0	0	0	0	0
77	Paul Ward 895-5015, McReynolds (530) 895-5111	CDFG	Butte and Big Chico Creeks Spring-Run Chinook Salmon Life History Investigation	Life history	Monitor and tag juvenile spring-run salmon and estimate adult escapement in Butte and Big Chico creeks	Rotary screw traps, snorkel	handle, mark, carcass survey	Year-round	Butte and Big Chico creek	No	No	0	0	0	0	0	0	0	0	20,000	0	720,000	12,320	0	5	530	10
78	Phillip Barrington (707) 825-4850	CDFG	2a6: Freshwater Creek juvenile salmonid abundance estimates	population estimates	Estimate population of juvenile salmonids	out migrant traps	handle	Year-round	Freshwater Creek	No	No																